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THE BRICKBVILDER

OFFICE 85 WATER STREET BOSTON

BRICK AND MARBLE IN THE MIDDLE AGES.

G. EDMUND STREET.

CHAPTER VIII.

(*Continued.*)

IF we return to the nave, we shall find that it is not only in general effect it is so very worthy of admiration; it still retains much of its old furniture, and, in spite of a few modern mosaics, and one or two more modern altars, is less altered in its general effect since the fourteenth century than any great church that I have ever seen. The screen between the nave and choir with the ambons on either side of it first deserve notice. The screen is mainly a work of A. D. 1394.[1] It consists of a series of columns carrying a flat lintel or cornice, on the top of which is a row of extremely good statues of the apostles. They have that grand sweep of the figure which one knows so well in early fourteenth-century work in France, and are free from the somewhat heavy and clumsy treatment which marks so much of the work of the Pisani. The screen has been raised on the base of the older Byzantine screen, which consisted of a simple continuous arcade now nearly hidden by the more modern steps to the choir. The ambons are probably of the same age as this older screen; the gospel ambon being of two stages in height, with a good staircase to it from the choir aisle, that for the epistle being comparatively low and simple, but still large enough to contain two or three modern pulpits. The screens to the choir aisles are of the same sort as the main screen, but are placed one bay to the east of it. They are all three interesting as showing that a Gothic architect could use with good effect a common Classic arrangement, and indeed lend fresh grace to it by the detail of the sculpture and inlaying with which he adorned it.

Dimly seen from the nave through the rood-screen, but far more interesting than even it, is the great baldachin or canopy over the altar in the choir. Here we have the simplest form — four columns carrying round arches, and the wall above them finished with a plain horizontal capping. The arches may be modern, though if they are so, they are copied from the old, as is evidenced by the painting at the back of the Pala d' Oro, which shows the placing of the shrine of St. Mark under a similar baldachin; but the groining is old, and the alabaster columns are of extreme interest, being covered all over with most elaborate sculptures of Scripture subjects. The subjects in the northeast column give the history of Joachim and Anna, and the birth of the Blessed Virgin Mary; the northwest has the nativity of our Lord, the marriage in Cana, etc.; the southwest, subjects from the Passion; and the southeast the miracles of our Lord. Few modes of decorating an altar are altogether so fitting and beautiful as this, and I hope the day is not far distant when we shall see many of our English altars standing under canopies of the same sort. St. Paul's Cathedral may well prepare the way for us in this, by reviving what was usually accepted as the best kind of reredos by our English church-builders in the eighteenth century.

[1] The inscription on the screen, which gives the date and the name of Doge Antonio Veyerio, gives also the names of the sculptors.

Here, too, is a brass eagle so like one of our own that one might almost give it credit for coming from an English smith or founder.

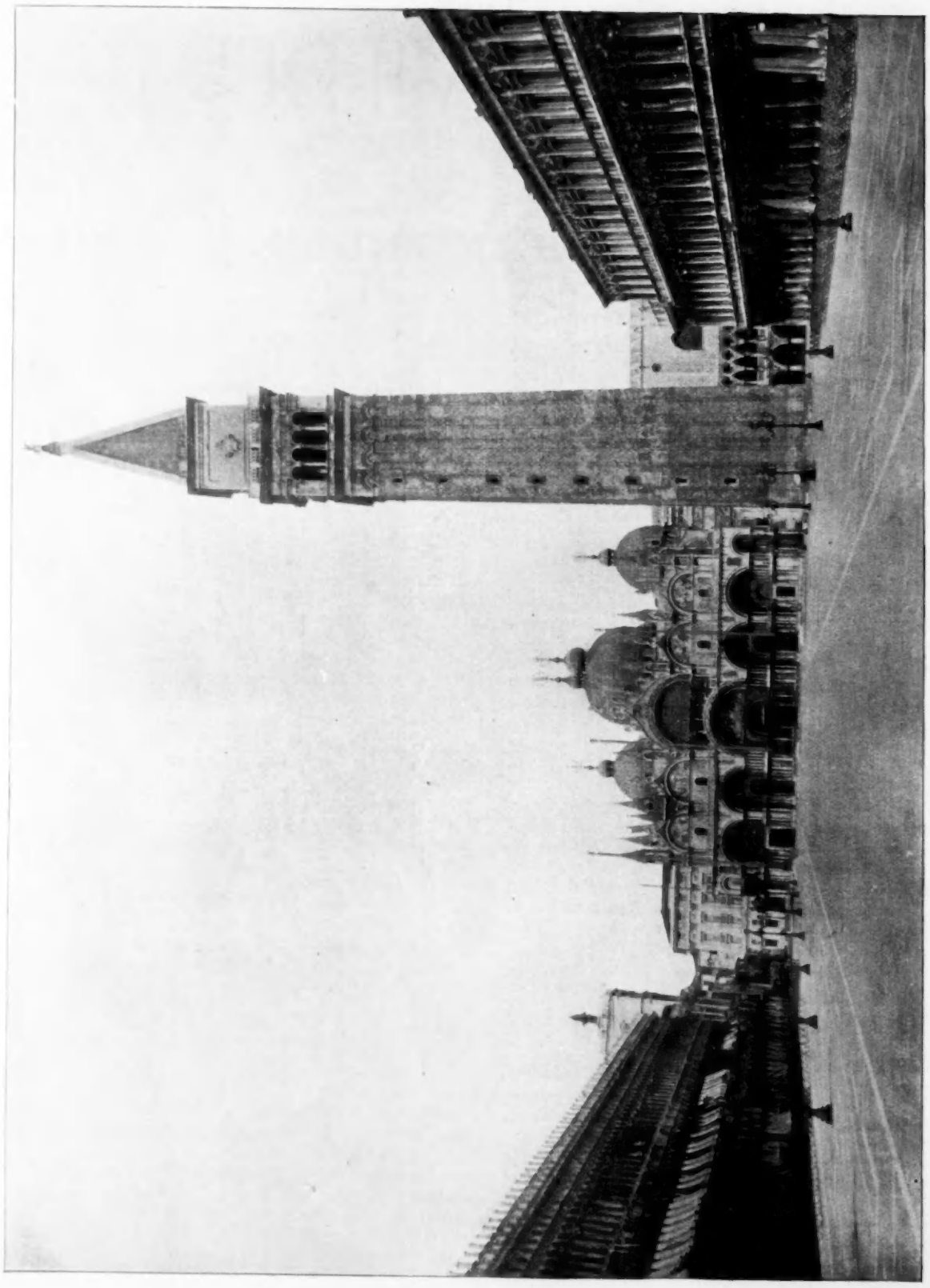
Returning to the nave, one finds nothing more worthy of admiration than another smaller baldachin over an altar between it and the north aisle. This is hexagonal, carried on shafts with stilted arches and roofed with a steep roof. Its dimensions render a small altar a necessity,— a matter of common occurrence in old examples. Another reredos and altar in a chapel at the north end of the north transept, dating from 1430, may also be noticed. Here the altar is panelled in front and carved with two angels censing a cross, and low open screens with arcades carried on shafts are placed a few inches from the ends of the altar. The footpace is not carried round the altar, so that it can only be approached from the front.

Of another sort of furniture — monuments of the dead — St. Mark's has, as might be expected, a good many examples. The earliest are the probably Roman sarcophagi,[2] which lie in the outer aisle or cloister, right and left of the entrance; the next, near them,[3] where the sarcophagus is still retained, but adorned with Christian emblems and sculpture; and of considerably later date, and much more artistic interest, are the tombs of the Doge Andrea Dandolo and of Sant' Isidoro. Here the sarcophagus is surmounted by a canopy, reverent angels stand on either side drawing back partially the curtains from the front of the effigy, and in the centre of the tomb is a bas-relief of the Madonna, and at the ends the Annunciation, St. Gabriel on one side, the Blessed Virgin Mary at the other. This is the type of monumental memorial on which so much of the time of Venetian sculptors seems to have been spent. Here, indeed, and on the very similar figures of the Virgin on so many of the tympana of doorways throughout the city, we have to study the sculptor's art from the time of the Byzantine carvers who wrought the still numerous early capitals, until the artist of the Ducal Palace came to revive the art with his original and splendid series of capitals.

But of all the features of this grand church, that which, next to the gorgeous color of the walls, most attracted me was the wild beauty of the pavement. I know not what other word to use which quite describes the effect it produces. It is throughout arranged in the patterns common in most Opus Alexandrinum, but, instead of being laid level and even, it swells up and down as though its surface were the petrified waves of the sea, on which those who embark in the ship of the church may kneel in prayer with safety, the undulating surface serving only to remind them of the stormy sea of life, and of the sea actually washing the walls of the streets and houses throughout their city. It cannot be supposed that this undulation is accidental, for had it been the consequence of a settlement of the ground we should see some marks of it in the crypt, and in the walls, and some tokens of disruption in the pavement itself. And the corresponding example of Sta. Sofia, Constantinople, where we have it on record that there

[2] The tomb of Vitale Faliero and another.

[3] The tomb of the Doge Marino Morosini.



PIAZZA S. MARCO AND CAMPANILE, VENICE.

SUPPLEMENTARY ILLUSTRATION TO "BRICK AND MARBLE IN THE MIDDLE AGES."

was an intentional symbolism in just such a floor, is conclusive as to the intention of its imitators here.

Of the mosaics with which the church is richly adorned I cannot pretend to give a complete account; they deserve a volume to themselves. As regards choice of subjects, it is noticeable that the most prominent figure is that of our Lord, who is seated, and surrounded by prophets. Below are the emblems of the four Evangelists, and the four rivers of Paradise. Whilst again, in the west dome, He is surrounded by the Apostles and the Evangelists, and everywhere the general scheme is a lesson to those who, nowadays, too often forget the relative importance, or the proper order and arrangement of the divine story, in the schemes they adopt for stained glass and mural decoration. As regards color, I need not repeat what I have already said; but it may be observed that wherever modern mosaics have taken the place of old ones, there at once we see a complete collapse, and a loss of all good effect. This is mainly owing, beyond doubt, to the attemp which their designers made to produce the effect of pictures, instead of thinking first and mainly of the decorative effect of their work on the building. But, at the same time, it is obvious that their eyes had lost all feeling for good color, and that in attempting to draw with a certain amount of academical accuracy they had equally lost all sense of the prime necessity in such works of simplicity of arrangement, and directness in the telling of their story. There is no part of the church in which some of the best of this sort of decoration can be studied with more ease and advantage than in the cloister on the north side of the nave. Here the mosaics are so near the eye and the details of design and color so fine that one is never tired of admiring them.

I never leave St. Mark's without taking one look at least at the four bronze horses, which, placed as they are on columns high above the ground, add so much to the strange character of the west front, and are in themselves such exquisite examples of their kind. Strange ornaments these for the façade of the chief church of a city where horses' feet have hardly ever trod! Equally strange, if you are to have horses in such a position at all, is the way in which these are supported. They stand balancing themselves nicely on the caps of small columns. Extremes meet; and I am not so sure but that this extraordinary arrangement is not better than that which is usually adopted. If horses are to be supported above the ground, they may almost as well be so in this way as on the ordinary pedestal, which looks equally unsafe if the bronze is instinct with life. These horses were brought from Constantinople after the fourth Crusade, circa 1203. They are of admirable character, and are probably of Greek workmanship. With every other movable thing worth moving, they were taken to Paris, and returned after the Peace in 1815.

There is a picture in the Accademia by Gentile Bellini which ought to be looked at after a visit to St. Mark's. In it we see the church much as it is at present; but an enormous procession which winds its tortuous way about the piazza defiles before houses every one of which seems to be ancient, and I never look at the now uninteresting lines of houses which surround it without wishing for the resuscitation of the buildings which Gentile Bellini saw and drew.

We went into the treasury to see the treasures and plate belonging to the church, but I was much disappointed to find that, in an artistic point of view, there was really very little to admire, or else what was admirable was not shown. The treasury is a dark room lighted up by a few wax candles, but so badly that it was difficult to see at all satisfactorily.

I was unable to obtain a sight of the Pala d' Oro, as the altar piece behind the high altar is called; it is only uncovered on feast days, and I have never happened to be in Venice when it was visible. I was very anxious to have seen it, as it is a most magnificent piece of workmanship in gold and enamel. It was executed in Constantinople, and brought to Venice in 1102. Some Italian writers have claimed it for their forefathers as an Italian work; but the documentary evidence of its Eastern origin is supported by the details of the design and execution of the earliest portions of the work. M. Durand has published a very careful description of it in the "Annales Archéologiques," Vol. XX. He gives a list of no less than one hundred and sixty-nine panels or figures, in a considerable number of which the accompanying inscriptions are in Greek characters. The Pala was "restored" in the thirteenth century and again in the fourteenth, when no doubt considerable additions were made to it. The painting at the back has fourteen subjects on a gold ground, and is dated 1345.

Over and over again, when at Venice, must one go into St. Mark's, not to criticise, but to admire; and if ever in any building in which the main object is the study of art, assuredly here one must go for worship also. I think I never saw an interior so thoroughly religious and religion inspiring as this, and it is well, therefore, not lightly to pass it by as useless for our general purposes. It seems to show, as strongly as any one example can, how much awfulness and grandeur of character even a small building may attain to by the lavish expenditure of art and precious materials throughout its fabric; for it is to this that St. Mark's owes its grandeur, and to this only. There is nothing imposing either in its size or in its architecture; on the contrary, they appear to me to be both moderate, and the former rather mean; and yet this grand display of mosaics upon a gold ground makes the building appear to be both larger and better than it is, and fully atones for all other defects. Could we but place one of our cold, bare places of worship by the side of St. Mark's, and let the development of Christian art in the construction of the fabric be ten times as great in our Northern church as in the Venetian, we may yet rest assured that every religious mind would turn at once to the latter, and scarce deign to think of the former as a place of worship at all. If this is so, does it not point most forcibly to the absolute necessity for the introduction of more color in the interior of our buildings, either in their construction or afterwards by the hand of the painter? And architects must remember that this ought all to be within their province as directors or designers, and therefore that they must not, as now, venture to design cold shells which may or may not afterwards receive these necessary and indispensable decorations, but from the very first must view them as part and parcel of the work in which they are personally concerned; and then, but not till then, shall we see a satisfactory school of architects in England.

The interest of St. Mark's is not, however, only religious and artistic, on other grounds it is certainly one of the buildings most worthy of study in all Europe. Its architecture is purely Byzantine; and whether its design was derived from Constantinople or from Alexandria, it presents us with an almost unique example of the architecture of the Eastern Church transplanted almost without alteration to the domains of the Western. Nor is this all; it played no small part in modifying the distinctly Roman influence by which otherwise the whole of Northern Europe would have been affected. When we see a church so far from St. Mark's as that of St. Front at Périgeux modelled after it, and in its turn influencing a vast number of churches in that and the neighboring districts, we may realize what St. Mark's did towards the development of Romanesque into new forms and combinations, and may then value properly every portion of its fabric. Byzantine architecture was the development of Greek art in the hands of the then vigorous and active Eastern Church. It is not a direct reproduction, therefore, of Classic art which is to be seen in St. Mark's, but one stage of a development the influence of which — partly owing to the effect of commerce, partly to her isolation — was largely felt down to the very last days of active Venetian artistic life. This has been well condensed in a short sentence by Mr. Ruskin. "All European architecture," he says, "good and bad, old and new, is derived from Greece through Rome, and colored and perfected from the East. The Doric and Corinthian orders are the roots, the one of all Romanesque buildings, — Norman, Lombard, Byzantine; the other of all Gothic, — early English, French, German, and Tuscan. The old Greeks gave the shaft, Rome gave the arch. The Arabs pointed and foliated the arch." But in the coloring and perfecting the church of St. Mark had the lion's share, just as in the ground plan it is to Venice and the East that we owe the cruciform arrangement of so many of our buildings, instead of the basilican form, to which we might otherwise have been condemned.

(*To be continued.*)

THE ART OF BUILDING AMONG THE ROMANS.

Translated from the French of Auguste Choisy by Arthur J. Dillon.

CHAPTER II. — *Continued.*

II. GROINED VAULTS. — *Continued.*

PERHAPS the desire for variety in architectural compositions sometimes caused the adoption of groined vaults when they were not imposed by the exigencies of construction, but the cases where they were adopted through motives other than those relating to art of building are rare, and almost everywhere we will find that, aside from the æsthetic reasons, their use was justified by those of a material order. We have, however, rather to indicate the means employed by the Romans in planning and constructing groined vaults than to discuss the cases where they were used; let us first consider their forms.

The Romans, in all cases, having a marked preference for simple solutions, endeavored to reduce their groined vaults to those formed by the intersection of barrel-vaults of equal width, for they could then give the barrel-vaults a circular form and avoid, at least in the transverse principals of centring, elliptical curves. To be exact, the Romans seldom bound themselves to give an absolute equality to the diameters of two intersecting barrel-vaults; if there was a slight difference between them they neglected it, and contented themselves with placing the summit of the vaults at the same level, keeping them circular. It was in this manner that the central hall of the Basilica of Constantine was vaulted.

The radius of the larger vault, C D (Fig. 39), was taken as the common height, and the smaller, also semicircular, was stilted, so that its total height A B was equal to C D. This slight stilting, which was necessary in the smaller of the vaults, was far from injuring the appearance of the edifice, for it gave it, on the contrary, an air of great elegance.

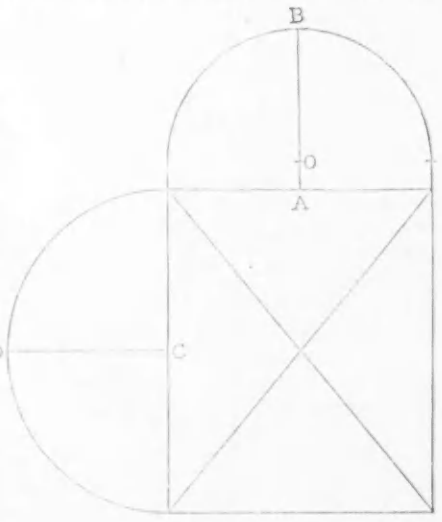


Fig. 39.

But the inequality of the sides of a hall was often so great that this expedient was not applicable, and then it was sought by means of a simple artifice to make the construction that of a vault on a square plan (Fig. 40). Thus only a square, A B C D, in the central part, made by taking A D and B C equal to the smallest dimension A B, was covered by a groined vault, while the remainder of the rectangle was covered by the extension, as A E of the longitudinal barrel-vault. This solution was quite common, but it must not be considered as universal, for it would be untrue to say that the Romans entirely excluded groined vaults of unequal sides and the resulting elliptical barrel-vaults. There is, for instance, a nearly intact hall in the Baths of Diocletian, which has three bays covered with groined vaults where the relation between the diameters of the intersecting barrel-vaults is about as two is to three. (Fig. 41, plan, and Plate IX., general view.)

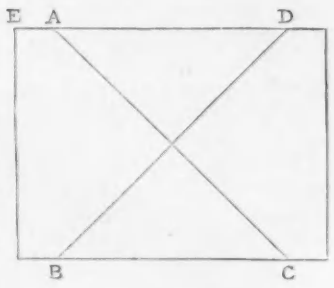


Fig. 40.

This vault is frankly *barlongue* and it is, moreover, the most remarkable instance known to me of a groined vault over a lengthened rectangle, but it is by no means the only existing example. The elliptical forms were not put aside until the time when the architects of Constantinople, the inheritors of the traditions and tendencies of the Roman art, thought of substituting for the classic groined vaults the eminently practical solution in Fig. 42.

Thanks to this ingenious arrangement of the vaulting, the more

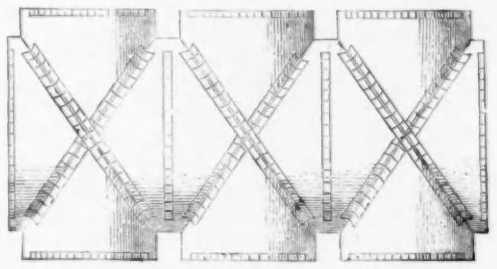


Fig. 41

or less irregular form of the plan ceased to be a cause of complications in the intersections. There might and might not have been a difference in the length of the sides, or the plan, at need, might have been a quadrilateral with unequal angles, but in every case the curves of the intersecting vaults would be semicircular, and the groins themselves were arbitrary, so that there was nothing to prevent their being drawn with the compass; and full centred principals only were necessary for centring. But here it is sufficient to indicate the relation between this Byzantine innovation and the Roman ideas; and we will again take up the question of ancient groined vaults, regarding them from the point of view of the methods of construction.

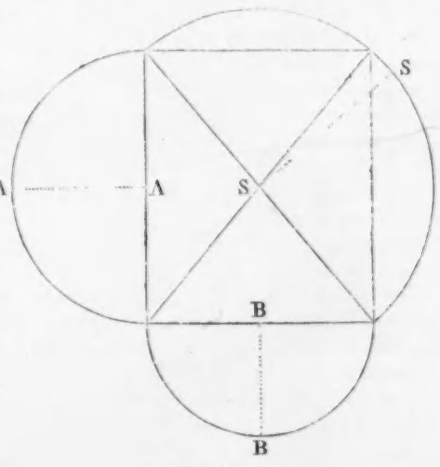
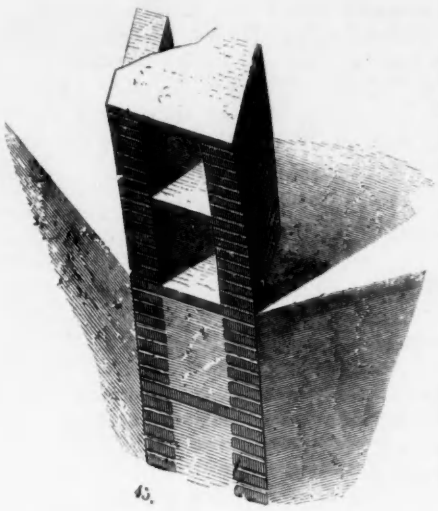


Fig. 42.

Whatever may have been the admitted forms of the groined vaults, the Romans facilitated their establishment by the employment of processes very similar, at least in principle, to those which were developed in considering barrel-vaults. Both were composed of two distinct parts, — the mass of rubble which formed the body of the vault and the open network or thin lining of brick which served as a support for the rubble during the construction, and was at least a partial substitute for the temporary centring which would otherwise have carried the load.

When they used the system of armatures of flat laid bricks, the



43.

Romans took care to protect the groin by a solid rib; small as the bricks might be in the rest of the lining, those along the groin were never less than forty-five centimetres on a side, almost always sixty centimetres, while their thickness was about five centimetres. The greater part of these tiles at the angles have disappeared, but their imprints, which still remain, clearly show their size and form, and one can easily realize the general appearance of the armature. Seen from above, before the laying of the rubble, it had the aspect shown above (Fig. 43), which is taken from one of the halls in the Baths of Caracalla. The same arrangement, moreover, with some slight variation, is to be found in Hadrian's Villa, the Palace of the Cæsars, etc.

The method of support by means of ribs was still more easily applicable to the exigencies of penetrating vaults. Ribs M and N (Plate IX.) were placed along the lines of intersection, and, if there was need, other secondary ribs (R) were thrown transversely from one pier to the other. But as these last differed in no way from the engaged arches used in barrel-vaults, I will confine myself to the construction of those along the groins (Fig. 44).

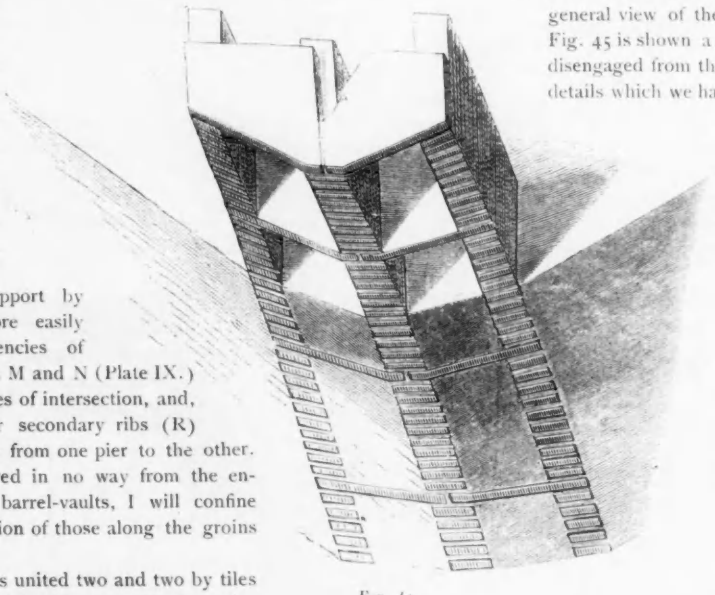


Fig. 44.

Three parallel arches united two and two by tiles formed, as it were, a solid backbone along the groin. It was necessary in order to place the bricks here to cut them to a certain extent in order to adjust them to the salient angle; but in place of cutting them in a regular manner by means of templates, the Romans contented themselves by clipping them as they were laid; and this was done in such a rough manner that it caused neither expense nor delay.

The only delicate operation was to construct the crossing of the diagonal ribs at the summit. There was no difficulty in closing one of the arches; M (Plate IX.), for instance, could be finished, but when it came to completing the other one, N, a complication arose, for the halves would press on the sides of the hollow rib M and threaten to crush it. Evidently it was necessary to fill with rubble the upper cells of the arch M before placing the last bricks of N, for when they were filled they were able to resist the crushing tendency, and the work could be completed without the slightest hinderance.

The great vaults in the Baths of Diocletian were constructed in this manner; and the usual method adopted for halls whose width was fifteen metres or more is of this type. In vaults of the smaller size the means of support were made less and less strong, and we will see the frame of brick simplified by degrees and its strength made proportionate to the efforts exercised on it by the mass of rubble. Following the logical sequence of the possible modifications, the Romans would have been led first to the suppression of the ribs R (Plate IX.) which cross the barrel-vault transversely; next to doing away with one of the three arches along the groins, and then two, thus reducing the armature to a single rib along each groin; and Roman architecture presents in this way all the intermediary steps between groined vaults with complete armatures and vaults with none whatever. We will endeavor to show by examples some of the different aspects which the skeletons of brick presented at different stages of this series of progressive transformations.

1. The form of armature which corresponds the closest to that which we have chosen as the type exists in a gallery of the Palatine near the southern angle of the hill (Plate VIII.). The diagonal arches are built exactly as in the Baths of Diocletian. There is the same number of elementary arches, and the method of obtaining a tie or bond between them is exactly the same, but in the Palatine the transverse arches were regarded as superfluous on account of the smaller size of the hall, so that it is exactly the combination shown in Plate IX., omitting the arches R which divide the vault into rectangular bays.

2. As an example of the diagonal ribs made of only two elementary arches I will cite only the groined vault in the central part of the so-caleld Portico of Janus Quadrifrons at Rome. A general view of the vault is given in Plate VII., and in Fig. 45 is shown a fragment of one of the diagonal ribs disengaged from the rubble which encloses it. After the details which we have already given it is hardly necessary to speak of the method of construction; one of the diagonal arches was built without considering the other; then two or three of the cells at the crown were filled and the second arch was closed.

3. We finally come to the case where the diagonal rib consists of a single arch of brick; there is an example of this simple solution in a hall of the Palace of the Cæsars (Plate VII., Fig. 4), whose ruins, isolated on a terrace of the Palatine, dominate the valley of the Great Circus. Each of the diagonal ribs (Fig. 46) consists of a single row of bricks in which are placed, from point to point, large square tiles whose shape is modified by a summary clipping.

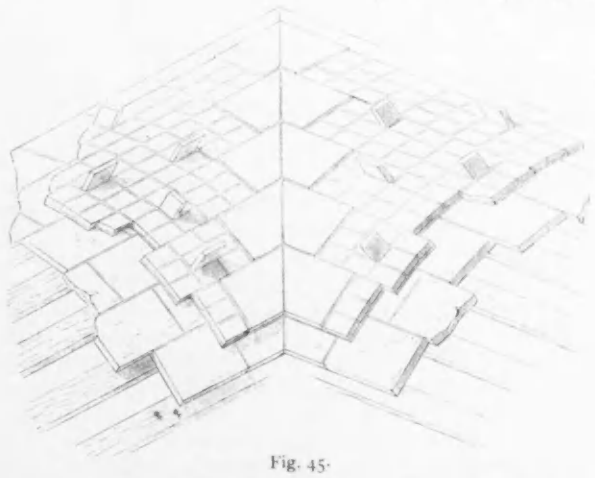


Fig. 45.

These projected from both sides of the arch and formed as it were headers which established a strong bond between the brick centre and the rubble.

We have come to the elementary form of armatures in groined vaults; to complete the picture of the transformations which this system has undergone during the centuries which precede us, it would be necessary, passing beyond the limits of Roman art, to trace across the Middle Ages the forms of the intersecting vaults built from the eleventh to the sixteenth century in the western countries of Europe. We would find in the diagonal ribs and the salient transverse arches of the vaults of those times the equivalent of the Roman skeleton; but there the arches have an additional function. The active life of the armatures in the Roman vaults was limited to the time when the rubble, not yet set, needed auxiliary support; once it had become hard the armature was confounded with it and had no more importance than the stability of the structure, while the Gothic armature, having the same utility during the time of construction, kept a distinct *rôle* even after the centring was removed. It carried the entire weight of the panels of stone which filled the spaces between the ribs, and through it the weight was transformed to a system of thrusts that were taken up by the weight of the abutments, or by the counter-thrust of the flying buttresses. The conditions of equilibrium were entirely different in the two cases, and in order to show analogies of any value we must confine ourselves to comparisons during the period of construction. Then, at least, the resemblance is perfect, and the Gothic vaults show under a new aspect all the essential characteristics of the groined vaults erected during the Roman Empire. But it would be to go beyond our programme to follow out the differences and analogies. We have shown the principal variations which were given to the armatures in groined vaults, and we will show in the following paragraphs how the same principles of construction were extended to vaults on circular plans, that is, to cupolas or domes and vaults of a quarter of a sphere.

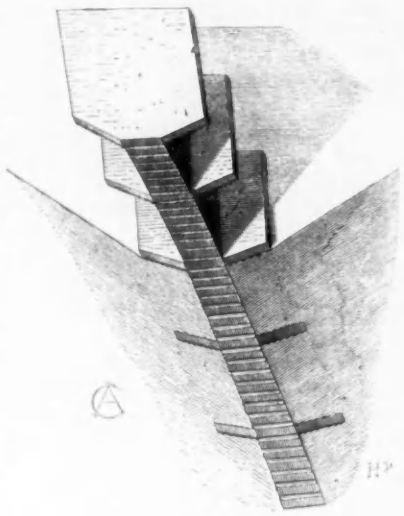


Fig. 40.

CIRCULAR VAULTS.

The vaults which bear the least on their centring are evidently domes; each horizontal section, because of its circular form, tends to sustain itself; and it would seem that a dome with a perfectly circular plan would have less need of an armature than of a mould to give it the required form. More than one ancient dome was indeed built with on other support than that afforded by its wooden centring, as, for example, the vault of the circular monument raised at the gate of Rome n honor of the mother of Constantine.

But the resistance to deformation resulting from the curvature of the surface decreased as the radius increased, and for domes like that of the Pantheon, where the curvature is almost imperceptible, the stability resulting from it may be said to be almost illusory. Even when they built on a smaller scale, the Romans seem to have feared the tendency of the masses to bear too heavily on their centres, and when the span reached a length of score of metres they considered armatures of brick useful in affording a necessary reinforcement to the temporary centring. In order to so strengthen the centring they sometimes attempted to revet the entire surface with a continuous network of brick, analagous to that shown in Plate I. But this envelope was hard to adapt to a spherical surface of a sphere. In order to do so it was necessary to place the lines of brick along the meridians of the vault, so that the meshes constantly varied in form and slowly and continuously diminished in size, — a condition which evidently would limit the application of this system. Hence circular vaults in which it is found are extremely rare; perhaps the most remarkable is that of the edifice called the "Torre de' Schiavi," at the left of the road leading from Rome to Préneste.

The method to follow in order to avoid the difficulties arising from the diminution of the meshes was to replace the continuous network by a system of isolated ribs dividing the surface of the vault into a series of segments.

On Plate X. is shown an application of this system. It is a vault from the ancient baths which stood behind the Pantheon at Rome. I have shown the armature only near the springing, for the upper parts seemed to me to be too vaguely indicated to allow of any attempt at restoration. Did the ribs of brick end suddenly by butting into a ring similar to that about the eye of the Pantheon (Fig. 49)? or did they cross like the groining ribs of intersecting vaults? The ruins give no reply; a street has been cut through the centre of the vault, and the part which still remains is, at the most, not more than the fragment shown in the drawing. The *débris*, however, has several claims to the greatest interest. If it comes, as is believed, from the Baths of Agrippa, its date is to be carried back to a time when Vitruvius alludes to baked clay as being among the usual building materials, and it is to be regarded as one of the oldest instances in the history of the art of building of the use of armatures of brick for vaults; and this supposition is certainly not contradicted by the aspect of the ruins. Everywhere the greatest care in the use of the materials is manifest, everywhere may be observed the minutest attention to the smallest details. Such characteristics would agree with a careful application of a new method; practice soon teaches builders to spare themselves pains, but here the workmanship is as good as the

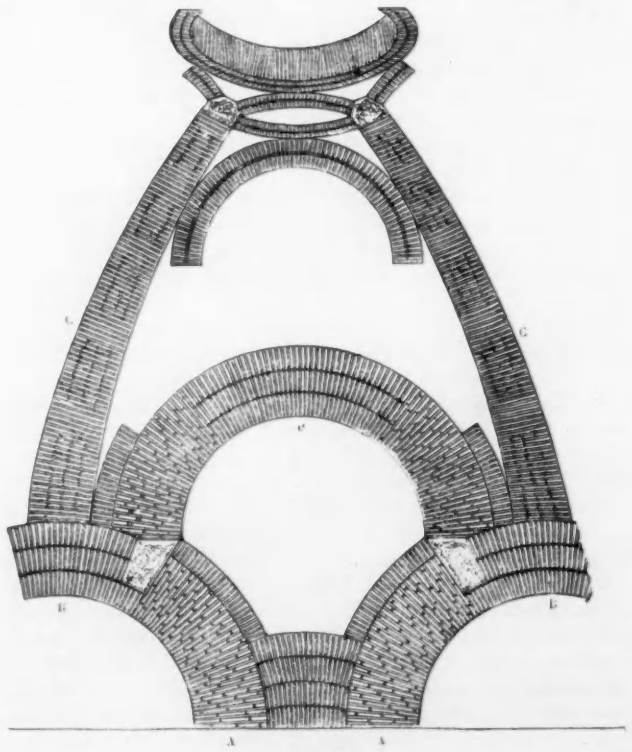


Fig. 49.

arrangement is well chosen, and though lighter armatures may be found in vaults of more recent date, it is needless to seek elsewhere for construction so correct or so irreproachable in regularity of form.

(*To be continued.*)

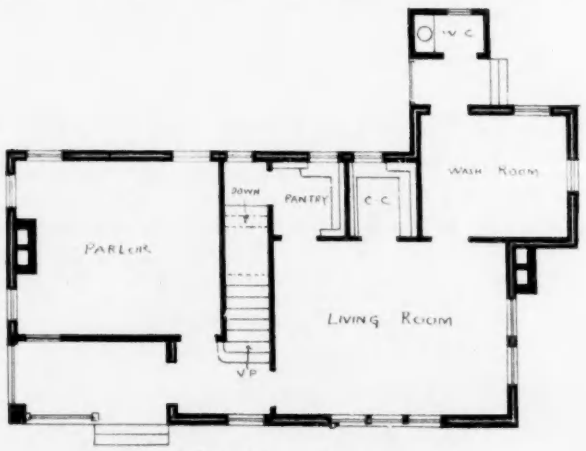
ON THE USE OF BRICK IN DOMESTIC ARCHITECTURE.

I.

WORKMEN'S COTTAGES.

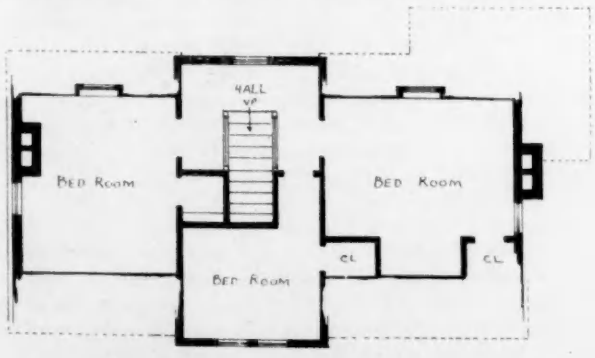
TO the traveller first visiting England there is, perhaps, no single phenomenon which surprises him more than the utter difference between English methods of building and those with which he has been familiar in America. This difference is not merely one which shows itself in works of engineering and heavy building, but it is equally obvious and even more surprising in the humblest grades of work, and in no place is it more startling than in the domain of house building, and that of the most modest kind.

In this country we are so familiar with the acres of shabby, flimsy, unkempt, wooden shanties that do duty as dwellings in the



FIRST FLOOR PLAN.

lower-class sections of our villages, and with the hundreds of acres of equally flimsy and incomparably more shocking and offensive mon-

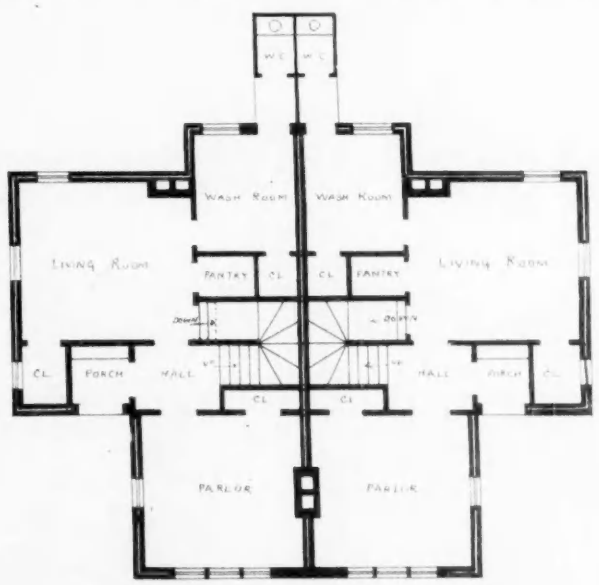


SECOND FLOOR PLAN

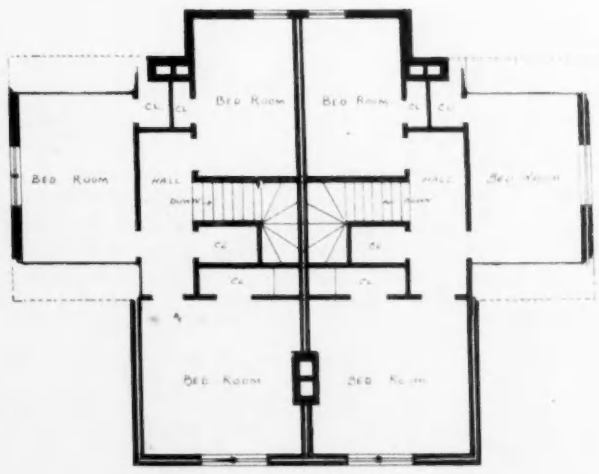
DOUBLE COTTAGE.

strosities that make up the better part of the residence portions of towns, that we never stop to think that really our wooden construction in this country from 1750 on is just as bad, just as illogical, just as stupidly inartistic as it can possibly be, and that for a century and a half we have been using a building material without the most rudimentary suspicion of its logical treatment or its great possibilities.

If it were otherwise, if we were surrounded by wooden construction like that of Warwickshire, Switzerland, Bavaria, or Japan, the shock might not be so great in passing from one of our rattletrap



FIRST FLOOR PLAN



SECOND FLOOR PLAN

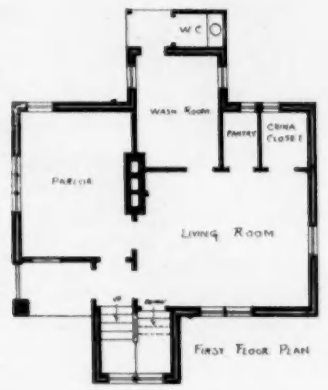
villages to the solidly built towns of England; but blighted as architecture has been by the ignorant misuse of a misunderstood material, perverted as our tastes have become through contemplation of imbecile wooden construction, the sudden discovery that mill towns and workmen's cottages need not be *quite* so dismally hideous and shabby as with us is apt to be something of a shock.

Outside the fire limits of cities the material now invariably used in the United States for the construction of the great majority of dwellings is wood. As a result we have an environment of æsthetic horror for those who live within the influence of Queen Anne, Colonial, and (save the mark) Romanesque cottages; we have flimsy, fire-trap barracks in the low-class quarters; and we have shabbiness, contagion, discomfort, and conflagration. And yet people uphold wooden construction because it is cheap, entirely forgetting that our national fashion of counting first cost only is quite as unpractical in this particular instance as in most others.

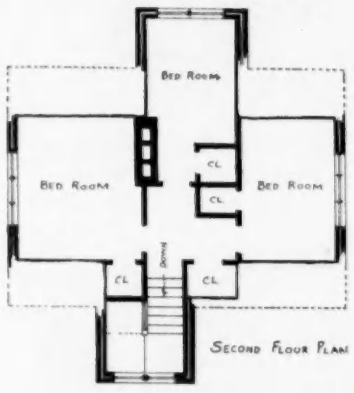
In England the matter is looked at in a more reasonable way, and as a result you find there, in the length and breadth of the country, hardly enough wooden houses to make up an ordinary American village. Every farmhouse, every workman's cottage, every barn almost, is built either of brick, stone, or half-timber work. It is unnecessary to mention the advantages thus gained; they are innumerable. Among all those which have a practical bearing on cost, sanitation, durability, protection against fire, etc., is one which is hardly considered, and that is the moral effect on the occupants. For my own part, I can't see how any man could live in an ordinary wooden factory block or a Queen Anne or Colonial cottage without being vulgarized, cheapened mentally, made uneasy, discontented, and miserable; while, on the other hand, a solid brick cottage, gathering dignified age day by day without losing anything of its stability, cannot help exerting an influence towards conservatism, permanence, self-respect, and dignity on its occupant. This may seem fanciful, but I believe it is based on reason. For an actual fact I know thousands of houses so "cheap and nasty" that I could imagine any crime, were it sufficiently sordid, being committed in any one of them, and through its direct and malign influence. Houses have more mental and spiritual effect on their tenants than we are willing to acknowledge.

But whether this be admitted or not, it cannot be denied that as between wood and brick as materials for domestic architecture, the latter has every advantage over the rival that now occupies the entire territory. Wood is but little cheaper than brick, even at first cost. By building a ten-inch wall of common red brick, two courses of brick with a two-inch air space, and by plastering directly on the inside brick, a wall is obtained which is stable, dry, warm, fireproof, and absolutely sanitary, while it costs but little more than the ordinary flimsy wall of clapboards, sheathing paper, boards, studs, back plastering, lath and plaster, the delight of cheap builders and also of rats, fire, germs, and decay.

And if the first cost of honest and healthy construction is only a little more than that of cheap woodwork, the running cost is much less. Paint is an artistic horror, and expensive as well. It can only be used in the fashion now in vogue, among an artistically barbarous people, and a wooden house must be painted every few years in order to keep it in repair and — according to accepted ideas — in a condition of attractiveness. A brick wall, if built of common brick, is always good, and in a little time it becomes beautiful. It will last pretty nearly forever, while it is far warmer, far more healthy, than almost any other wall.



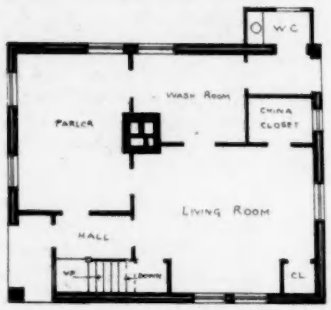
Why then is it not used? Well, first, because its cheapness is not appreciated; and second, for the reason that the mental temper of the time does not demand or even consider permanence and honesty in the construction of ordinary dwellings. The cheap builder cuts construction down to the very limit where his studs and joists and boards will hold together until the house is sold, putting what little money he spends into what he fondly holds to be



ornamentation, viz., paint, stained glass, and *papier-maché*. Consequently we find in "progressive" towns whole districts made up of flashy and tawdry horrors doomed to certain and speedy shabbiness, if before the expiration of the few years necessary to bring this result the houses themselves have not collapsed into rubbish heaps. If "cheap clothes make a cheap man," very certainly cheap houses make a cheap people, and it would do no harm for us to look to it that we avert, if it is not already too late, this undeniable danger.

Arguments of this nature and towards this end will of course have absolutely no effect whatever in obtaining any reformation in domestic architecture; it will be necessary to show that a house may be built very largely of brick at a cost which will be but little greater than that of good wood construction. The plans and sketches which accompany this article are intended to show this. They deal with the simplest form of dwelling, a five-room, workman's cottage, to be built in

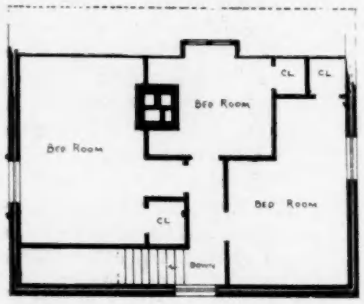
the country or in villages which have no system of sewerage. In each case the accommodations are the same, viz., a kitchen or living-room, a parlor, pantry, china closet, and wash-room, on the first floor, and three bedrooms above. The cellar is under only a portion of each



FIRST FLOOR PLAN

house, and there is no furnace. The walls are built of common red brick laid in white mortar, and are ten inches thick, including a two-inch air space. Inside, the plaster is placed directly on the brick. The finished woodwork is cypress or Washington cedar, finished natural with two coats of shellac; it is perfectly plain, without mouldings, even in the doors; the living-room and halls have rift hard-pine floors.

It is easy enough to imagine the ordinary wooden house that would be built for the same amount of money that one of these cottages would cost. It would probably have clapboards on the first story, shingles on the second. If it were Queen Anne, it would have turned balusters and columns all over it, with a fluted or jig-sawed panel perhaps. Its roof would be "picturesquely irregular," with little curved dormers in it. The glass in the windows would be



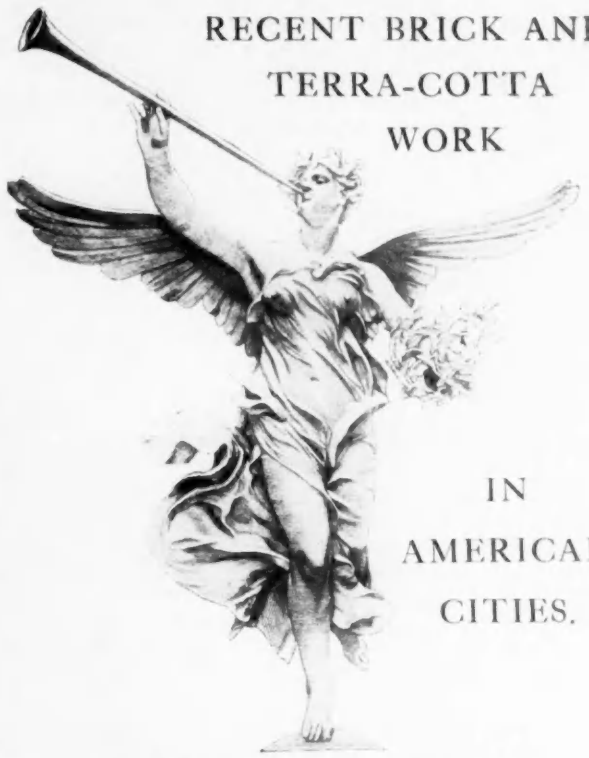
SECOND FLOOR PLAN

cut up into fantastic shapes, and that in the panel of the front door would be violently colored. If it were "Colonial," it would have *papier-maché* festoons stuck on, and be painted yellow and white; otherwise its colors would be innumerable and chaotic. Rank, ridiculous cheapness would stick out all over it, and it would sell netting the builder twenty-five per cent on his investment. Whether such a house as one of those indicated in the accompanying sketches would sell or not must remain to be proved. At all events, it would be an honest house, while the others could pass only as shanties.

Its first cost would be a little more than that of wood; this cannot be denied. But the extra cost would not exceed $150 on each house. A speculative builder would never think of squandering this sum on a house which would sell just as well if it were built of wood and "tastefully" painted; but it is hard to believe that an average workman of good sense, building a house for himself, would, if he knew the facts in the case, hesitate for a moment over the two courses before him. If men of this kind can be induced to see the immense advantages of a brick house over a wooden shanty, not only in point of health, comfort, and durability, but actually in the matter of first cost, we may yet see some good honest building in the country, where now we have only too much of shameful and shabby cheapness.

RALPH ADAMS CRAM.

RECENT BRICK AND TERRA-COTTA WORK IN AMERICAN CITIES.



TERRA-COTTA FIGURE IN HIGH RELIEF.
EXECUTED BY THE AMERICAN TERRA-COTTA AND CERAMIC CO.

THE WORTHINGTON BUILDING, BOSTON.

FEHMER & PAGE, ARCHITECTS.

THIS new building, which is to occupy the site of the old Traveller Building, 31 State Street, corner of Congress Street, covers an area of about 2,600 feet; is to be a modern office building in all respects, and absolutely fireproof throughout.

The building is designed in the style of the Italian Renaissance. The first two stories, belt courses, window trims, and main cornice are of Indiana limestone, of a light gray color; the remainder of the building is of brick and terra-cotta, made by The New York Architectural Terra-Cotta Company to match the stone work, so that the building will be uniform in color for its entire height.

The treatment of the State and Congress Streets fronts is carried around the building. The stone work around entrances and window openings will be elaborately carved, and handsome grille work of iron or bronze will be introduced in toplights and openings over same.

The steel frame has been designed to insure an absolutely substantial structure, and so constructed with steel-plate girders and uprights as to form a continuous wall of steel the entire height of the building back of the masonry.

The most careful study has been given to designing this frame to guard against wind-pressure, or from any annoyance caused by vibration.

The steel frame throughout the building will be protected on the exterior and interior by masonry.

The principal entrance is in the centre of the building, with hallways extending through to the entrance on Congress Square.

At the left, as one enters from Congress Street, is the entrance to the basement, over which, leading from the main hall, is the staircase to the second story. At the opposite end are two elevators running from basement to tenth floor.

The basement, first, and second stories are planned with the hallways occupying the centre of the building, opening off from which, through double doors, are the two large banking offices, one on each side of the hall.

In addition to this entrance from the main hall, the banking office on State Street, first story, has a private street entrance, which forms one of the features of the State Street façade.

The finish in the first and second story offices will be of mahogany, with mosaic floors and handsomely panelled ornamented ceilings.

The upper stories are planned with the elevators and staircase occupying the central portion of building on Congress Square side, with hallways extending through the centre of building and offices opening off on each side. The partitions are brick and terra-cotta blocking throughout. (See Plates 9, 10, and 11.)

MR. ROBERT H. FOEDERER'S RESIDENCE, PHILADELPHIA.

HAZELHURST & HUCKEL, ARCHITECTS.

THIS is the latest of the many elegant residenes built on North Broad Street. It is constructed of buff Roman-size brick and white terra-cotta, with first story of Indiana limestone. The columns to front entrance and loggia above third story, also spandrel over the main door, are Pabanazza marble. The terra-cotta work was made by Stephens, Armstrong & Conkling of Philadelphia, and the brick by the Eastern Hydraulic-Press Brick Co.

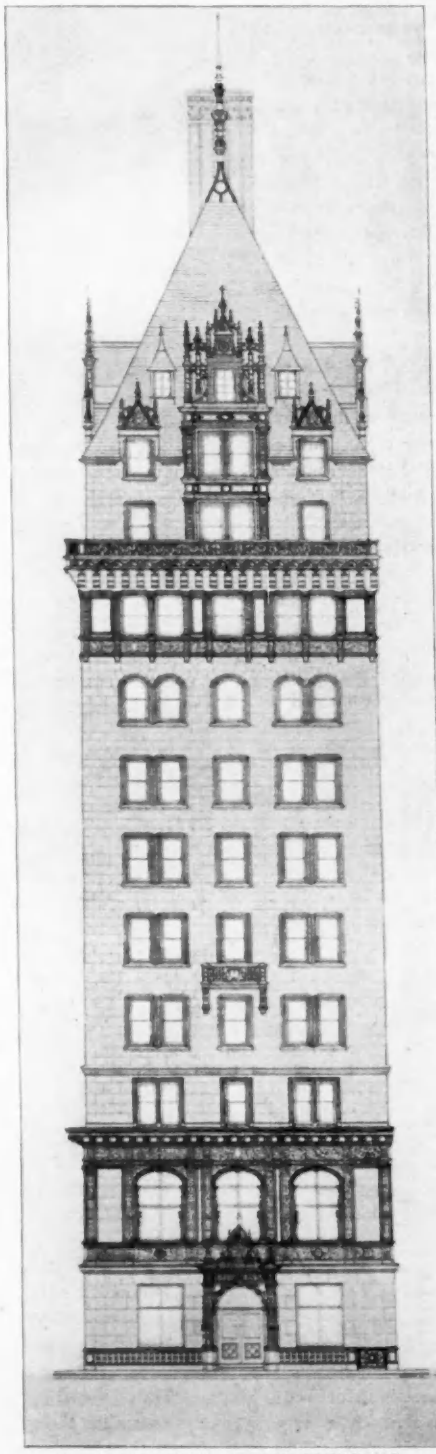
The color tone of the building is exceedingly pleasing, and, with the details and modelling, has been carried out with great care and fidelity, and is another example of the use in combination of brick and terra-cotta in Philadelphia buildings of recent date.

For elevations and plans see Plates 12, 13, and 14.

HARRISON OFFICE BUILDING, PHILADELPHIA.

A TYPICAL terra-cotta building. Terra-cotta from first to twelfth story, outside and inside, partitions, beam coverings, floors, flues, and stack, all of this material, which is so suddenly springing anew into use as a first-class building material. This building shows, more than any other in this city, the possibilities of terra-cotta as taking the place of stone in large commercial buildings, and may be considered as marking a new era in terra-cotta construction.

Beginning at the base, we have several courses of Indiana limestone to the tops of the sills of the first-story windows, where the terra-cotta commences. This stone wall is backed with bricks, and is the only instance of the use of bricks in the building. From this point to the top the walls are entirely of terra-cotta, save of course the steel framing. The first story shows massive blocks of terra-cotta, some being as large as twenty-one inches by forty inches on the face, and thirty-four inches deep in the wall. The blocks will be built up as usual in the heretofore smaller work, having a sufficient number of horizontal and vertical partitions or ribs to prevent any undue distortion of the blocks during the process of burning. They will be closed entirely on all sides, except the necessary small openings at the ends, and will be keyed on the top, bottom, and sides. The cornice blocks, bonding courses, and corbels will extend entirely through the walls and be scored on the inside to receive the plastering; other blocks will extend about half-way through the walls, forming a bond with the interior backing, which is of the same material made somewhat lighter in section and weight and likewise scored for the plastering.



THE HARRISON OFFICE BUILDING, PHILADELPHIA.
COPE & STEWARDSON, ARCHITECTS.

The face of the walls will be finished similar to fine tooling as used in stone; and the first, second, third, ninth, and tenth stories exhibit a richness of detail seldom attempted in buildings which are purely utilitarian; the second story, the two principal entrances, and the large dormer-windows being especially rich. The ornamentation of the second story is taken from one of the façades of the Hotel Bourgtheroulde, and the architects have very successfully designed the cornice over this story in perfect harmony and proportion to the ornament under it, as well as to the entire mass of the building.

The building presents several unique features. In the first place we think it sets forth the first instance where a stack for the fireplaces and boilers is constructed of a steel frame with curtain walls. It is rigidly connected to the frame of the building, and extends in height a distance of about one hundred and fifty feet from the first floor. It also shows a treatment of the party wall which is very commendable, as it is kept entirely clear of the party line, and can never be disturbed by the erection of any neighboring building. It is built of the same material as the fronts, and the upper stories are treated in the same richly ornamental manner. Thus it will be seen that the view of the building will be beautiful from all points of sight, and will not be marred by the usual unsightly party wall.

Another step well taken, we think, is the determination of the architects, Messrs. Cope & Stewardson, to prevent if possible in this building the top-heavy and hollow appearance of the walls, so perceptible in many of the high buildings recently built. They purpose to do this by building the walls with a regularly defined entasis, the same as is usual in high columns, and strengthening the effect thus produced by forward projections in the first and second stories, and by setting back or receding the walls in the extreme upper stories. In this manner the top of the wall is receded so that at the eaves of the roof the face of the wall is seventeen inches back of the face at the first story; and the perspective drawings, carefully made with a view of determining the exact effect of this treatment, show an improvement in the appearance of the whole which is entirely satisfactory. The dormer-windows and face of the stack, which extend above the eaves, are made to continue the entasis and also slant backward correspondingly, instead of being perfectly vertical.

The manner of the construction of the steel frame, which allows of the treatment above referred to, is very interesting, and in some instances unique, but cannot be dwelt upon here.

The style of the building is the French Renaissance of the period of Francis I., and it will be seen that the style has been strictly adhered to in all the details, this being true especially of the ornament, which is very rich, discreetly used, and highly appropriate.

The Perth Amboy Terra-Cotta Company, who have taken the contract for the terra-cotta required for the work, furnished about a dozen large blocks of different kinds and shades of terra-cotta, made up in the manner described, for preliminary testing, etc. They were built up, plastered, and weighed; and it was found that the plaster adhered firmly to the material, and that those blocks made with a thickness of shell and webs of one inch weighed fifty-five pounds per cubic foot, while those having shell and webs of one and one half inches weighed seventy pounds; this weight, when compared to the weight of stone or brick, gives a fair idea of the saving in total weight effected by the use of this method.

The floors are of the usual hollow arches, end construction, with a topping of cement concrete for floors, and a wood strip around the edge of each room for carpets if desired. There is no window trim, except a wood sill; and this sill, the doors, and baseboards sum up all the wood in the building. It is therefore strictly fireproof throughout.

SIBLEY MEMORIAL HOSPITAL, WASHINGTON.

CLARENCE L. HARDING, ARCHITECT.

ILLUSTRATIONS of elevation and floor plans of this hospital may be found in Plates 15 and 16. The hospital was a gift to the city of Washington from Mr. Wm. J. Sibley, as a memorial to his wife. It is considered a very good example of what can be done with a comparatively small amount of money, the entire cost not exceeding $10,000. The front is of brick and terra-cotta. The vestibule, baths, lavatories, operating and emergency rooms have floors of unglazed, vitrified, encaustic tiles. The sinks, bath-tubs, and slop-sinks are porcelain, and the plumbing is a fine feature throughout. Each ward accommodates ten beds, and the whole building is complete in all of its appointments.

MORE BRICK BUILDINGS.

A FEW more new buildings were started in Boston this January than last, the gain being in brick structures, which numbered thirty-seven against thirty in 1894. Permits for frame buildings decreased two, the number being seventy. Considering the large increase during the latter part of 1894 over 1893, this showing is favorable.

Compared with January, 1893, the gain in brick construction is remarkable, the number that month being only eight. The frame buildings this year were fourteen fewer, however.

BUFF BRICK IN NEW YORK.

BUILDERS and dealers in building material believe that the buff brick is to be a permanent and increasing conspicuous feature of New York architecture. Several considerable buildings of that material are now going up. The North Jersey fire clays, from which the buff brick is made, are seemingly inexhaustible, and the material can be brought to New York very cheaply. Some of the clays that lie near those used for these bricks are too valuable for ordinary building purposes, and are sent all over the country to be worked up for other uses. The crude clay is worth in some instances $100 a ton. If the buff brick can be reduced in price, its use will be greatly extended, because houses and office buildings of that material rent more easily than equally well-situated buildings of other materials. Luckily for house owners, the mere cost of front brick, whether red or buff, is not an important item in the construction of a considerable building, so that even a slight reduction in the price of buff brick would probably greatly extend the use of that material. — *New York Sun.*

THE STRENGTH OF OLD BRICKWORK.

AN interesting piece of information respecting the strength of old brickwork is the result of experiments carried out by Mr. A. G. Lyster, the assistant engineer to the Mersey Docks and Harbour Board. The brickwork in question was part of a wall of the Albert warehouses in Liverpool, and was built about fifty years ago of hand-made bricks laid in ground mortar made with lime from the Halkin Mountain, Flintshire. This lime is in a high degreee hydraulic, and makes mortar of exceptionally good quality. Having to demolish the wall, Mr. Lyster conceived the happy thought of leaving a piece of it in the form of a horizontal beam, having a twelve-foot span, and measuring about two feet square in section, seven courses in height of a two-foot wall. The ends of the beam were not cut free from the rest of the work. This beam was then loaded with all the weight that could conveniently be piled upon it in iron "kentledge," without appreciable deflection or other sign of weakness resulting. Two courses were then cut off, and the whole weight again put on, but without other result. The beam was further reduced by a course, leaving it four courses, or fourteen inches deep, and the ends were also cut free from the other work, the mortar beds of the twelve-inch bearings being left untouched. A centrally placed load of five tons, fifteen hundredweight was then gradually piled upon it, and was borne for several days without apparent effect upon the brickwork. Finally, the weight was increased to six tons, nine hundredweight, twenty-three pounds, which was sustained for thirty hours, when the beam collapsed during the night, and came down in pieces more like broken timber than anything else. Other tests were made with similarly astonishing results; but the above are sufficient to show what really first-rate brickwork in hydraulic lime will stand.— *British Clay Worker.*

J. W. MORRISON, architect, has opened offices at 313 Jefferson Street, Jamestown, N. Y.

THE firm of Brede & Zimmerman, architects, Detroit, Mich., dissolved partnership Feb. 1. Mr. H. A. Brede will continue the business.

FRANK HORTON BROWN, architect, has removed his offices to White Plains, N. Y. The Port Chester office will be continued as a branch at which Mr. Brown will spend Wednesdays of each week.

THE Van Rensselaer house, opposite Albany, N. Y., is believed to be the oldest inhabited house in the United States. The building was erected, it is said, in 1642, of bricks imported from — Holland. *The Southern Architect.*

THE Architectural League of New York began their tenth annual exhibition of Architecture, Painting, and Sculpture in the galleries of the American Fine Arts Society Building, 215 West Fifty-seventh Street, on the 15th of February. The exhibition closes the 9th of March.

THE Chicago Architectural Sketch Club seems to be a very much alive affair, as may be seen by the following programme: Monday evening, Jan. 21, Mr. Thomas Hastings's paper on planning was read and illustrated by stereopticon views; Monday evening, Feb 4, a musicale by the members of the Marquette Club Minstrels; Monday evening, Feb. 11, a "Rip Snorter." (For particulars apply to Billy Gibbs, Bob Williamson, or Major Hoeppner, hosts.) On Monday evening, Feb. 18, Mr. F. G. Perkins read a paper entitled "The Comparative Merits of Steam and Hot Water Heating," this paper being the first of a series upon practical subjects.

OUR ILLUSTRATED ADVERTISEMENTS.

THE Hydraulic Press-Brick Company has chosen as the subject for this month's illustration in their advertisment (see page xvii),

THE CATHEDRAL AT ASSISI.

This company is the parent of the many hydraulic companies that exist in the several parts of the country, addresses of which are given in the advertisement, and the liberality it shows in the matter of expense in publishing these excellent examples of old brickwork is certainly commendable and very much appreciated.

THE COLONIAL CLUB,

Henry F. Kilburn, architect, one of the noteworthy buildings recently erected in New York, is chosen for illustration by the New York Architectural Terra-Cotta Co. (see page xvi). It is a pleasing example of the excellent effect that may be obtained by the use of the lighter shades of brick and terra-cotta in exterior work. We publish herewith three bits of detail executed by the New York Company who supplied the terra-cotta. The buff brick used in the façade was furnished by Sayre & Fisher Co.

Another faience medallion executed by Andre della Robbia is the fourth in the series of illustrations by the Atwood Faience Company (see page xv). Particular interest attaches itself to the work being done by this company (examples of which we shall publish in our later numbers), owing to the fact that a great deal of faience work is now being used in exterior work in Chicago.

NEW ADVERTISEMENTS.

WITH this number we begin the advertisements of Sayre & Fisher Co., of New York, manufacturers of fine pressed front and enamelled brick. (See page xiv.)

The Peerless Brick Company of Philadelphia, one of the oldest established front brick concerns in the country. (See page xiv.)

The Philadelphia Enameled Brick Works. (See page ii.)

The Northwestern Terra-Cotta Company of Chicago (see page v), who have executed some of the best designs in architectural terra-cotta that are to be found in this country.

And last, but not least, the Pioneer Fire-proof Construction Company of Chicago. (See page iv.)

NO doubt most of our readers will recall the announcement in our September number of the fact of the total loss by fire of the American Ceramic Terra-Cotta Company's works on the 20th of last September, also the statement that, with their characteristic energy, the company had commenced rebuilding at once. How rapidly this work of construction must have gone on may be imagined when it is stated that within three short months the present substantial, well-arranged buildings have been erected and equipped with all the latest and best improvements in machinery for turning out terra-cotta. Although such a catastrophe as that through which the company has recently passed is always a hard blow to immediate business, still it has some later benefits in the reconstruction of the works. As in this case, the company, profiting by their past experience, rearranged the entire general floor plan of their buildings with a view to the most expeditious location of each department for its particular work, and then equipped the same with such machinery as in their judgment was the best possible for the purpose, and which would yield the best results. We are told that in time alone (that great bugaboo to the terra-cotta manufacturer) the company have been enabled to save a quarter over that which they formally required to complete work, owing to the many advantages of their present arrangements, and this in addition to the fact of the work being better in quality than before. It would be hard to find a more interesting operation than to watch the evolution of the coarse gray clay into the graceful terra-cotta designs, with their beautiful colors and harmonious effects. That this particular branch of the terra-cotta industry is in its infancy all are ready to admit. What it shall mean to the building profession when it shall arrive at that state of incorporating into its structure all the beautiful color effects that are now promised, who dares to prophesy!

ANOTHER "BRICKBUILDER" COMPETITION.

WE are making arrangements to hold another competition, open to subscribers of THE BRICKBUILDER, for which suitable cash prizes will be offered. The subject will be "A City House," fireproof throughout, with a brick and terra-cotta front. The limit cost and details will be announced in the March number. As has been our custom, we shall publish the successful designs.

To clubs of five and ten or more draughtsmen, wishing to subscribe to THE BRICKBUILDER, we make a special rate. To one who will act as our agent in securing subscriptions, we will allow a liberal cash commission. Write for particulars.

TO DRAUGHTSMEN.

ANY draughtsman out of employment, who will send us his full address and answer the following questions: —

By whom were you last employed?
Can you furnish good recommendations from your last employer?
On what particular line of work have you been engaged?
What salary do you expect to receive?
Are you willing to go to another city?

may have his name placed in our Exchange Bureau, and will be notified of any parties desiring his services as a draughtsman.

All such communications will be regarded as confidential, and no charge will be made.

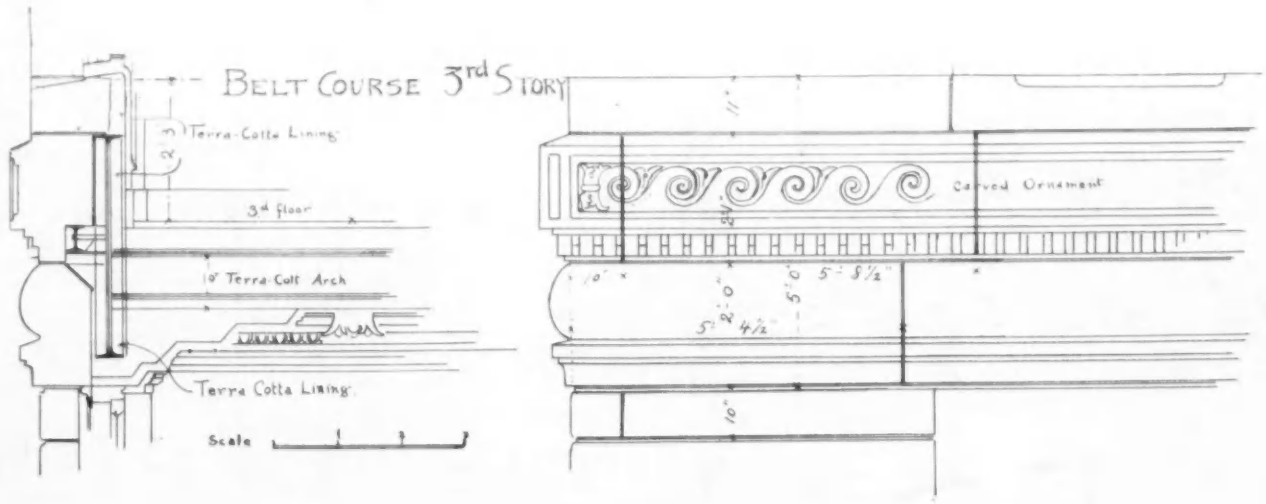
Address, EXCHANGE BUREAU,
THE BRICKBUILDER PUBLISHING CO.

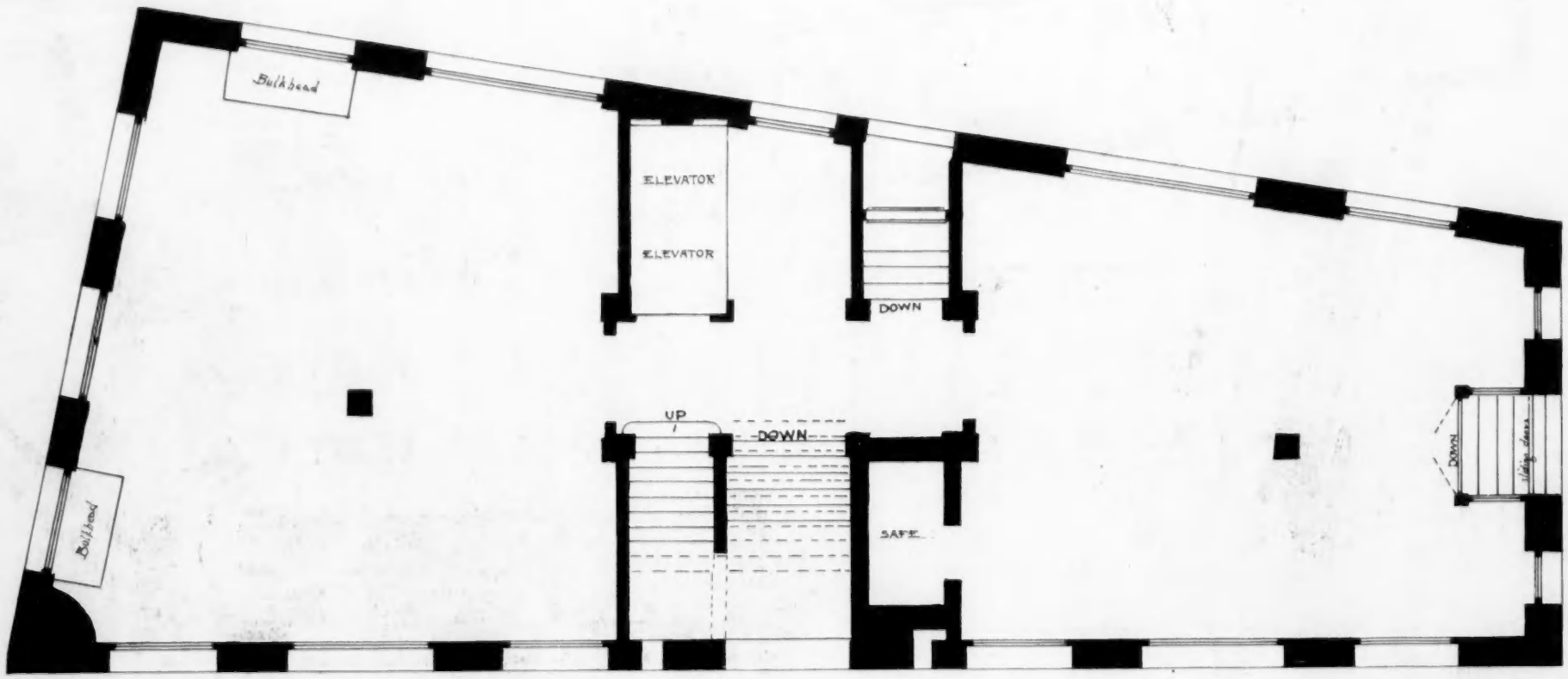
TO ARCHITECTS.

WE call your attention to the foregoing announcement, and upon your application would be pleased to put you in communication with any draughtsman whom we think would meet your requirements. All communications will be regarded as confidential, and no charge will be made.

Address, EXCHANGE BUREAU,
THE BRICKBUILDER PUBLISHING CO.

WORTHINGTON BUILDING, STATE STREET, BOSTON.
FEHMER & PAGE, ARCHITECTS, BOSTON.



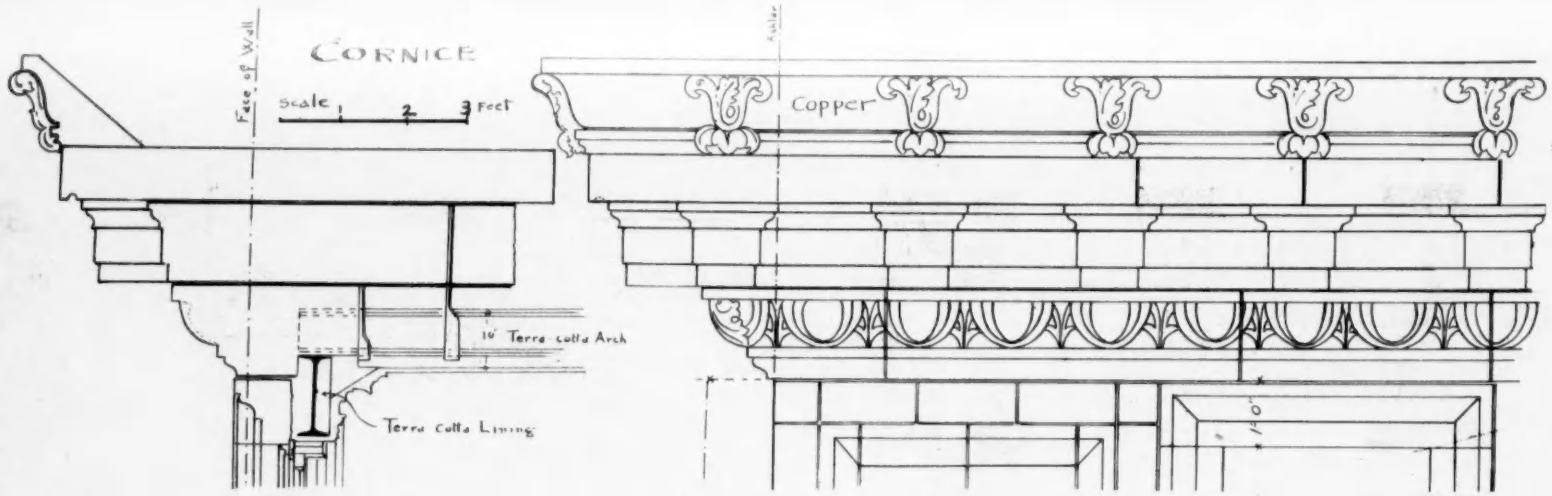


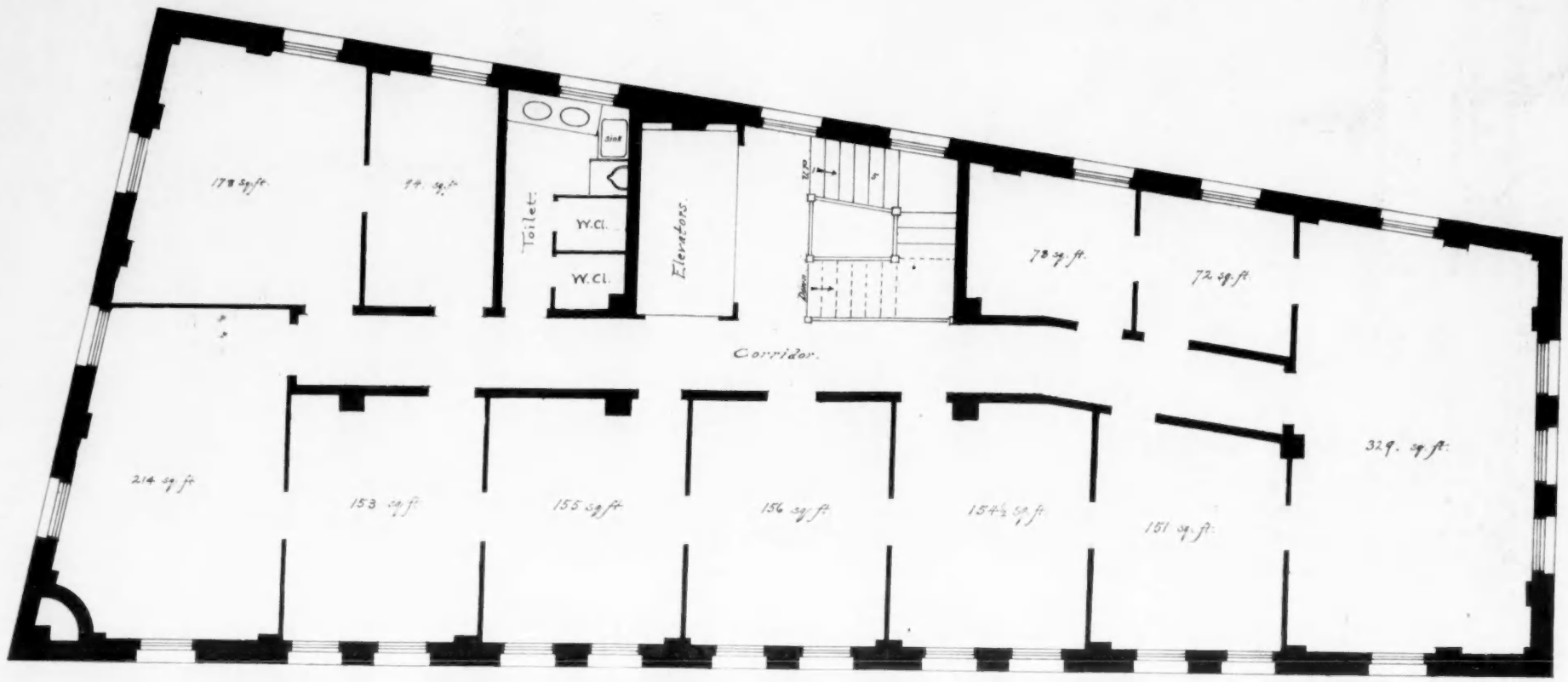
FIRST FLOOR PLAN WORTHINGTON BUILDING

Scale 1/8 in. = 1 ft.

20 15 10 5 0 Scale Feet.

FEHMER & PAGE ARCHTS.

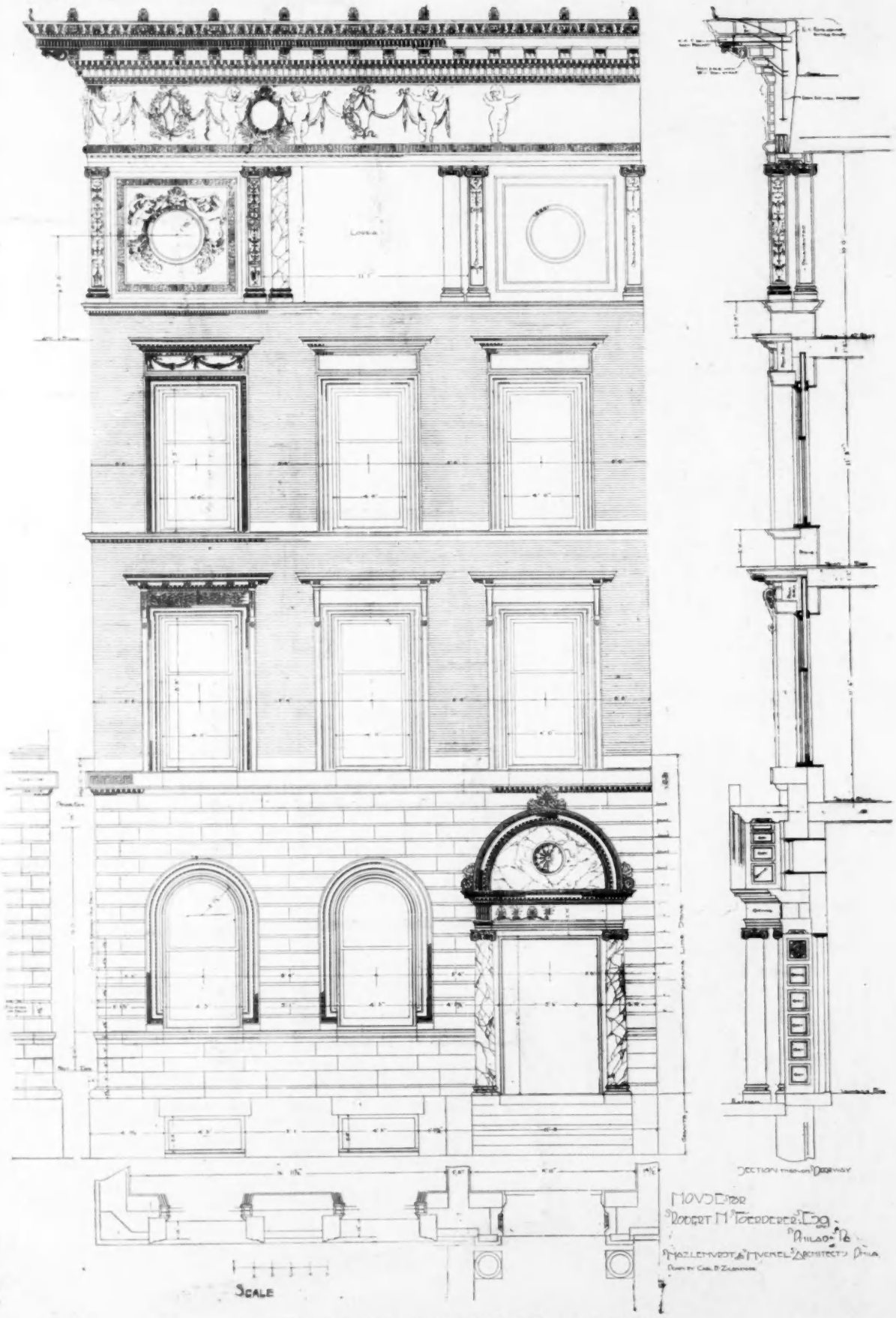




THE WORTHINGTON BUILDING

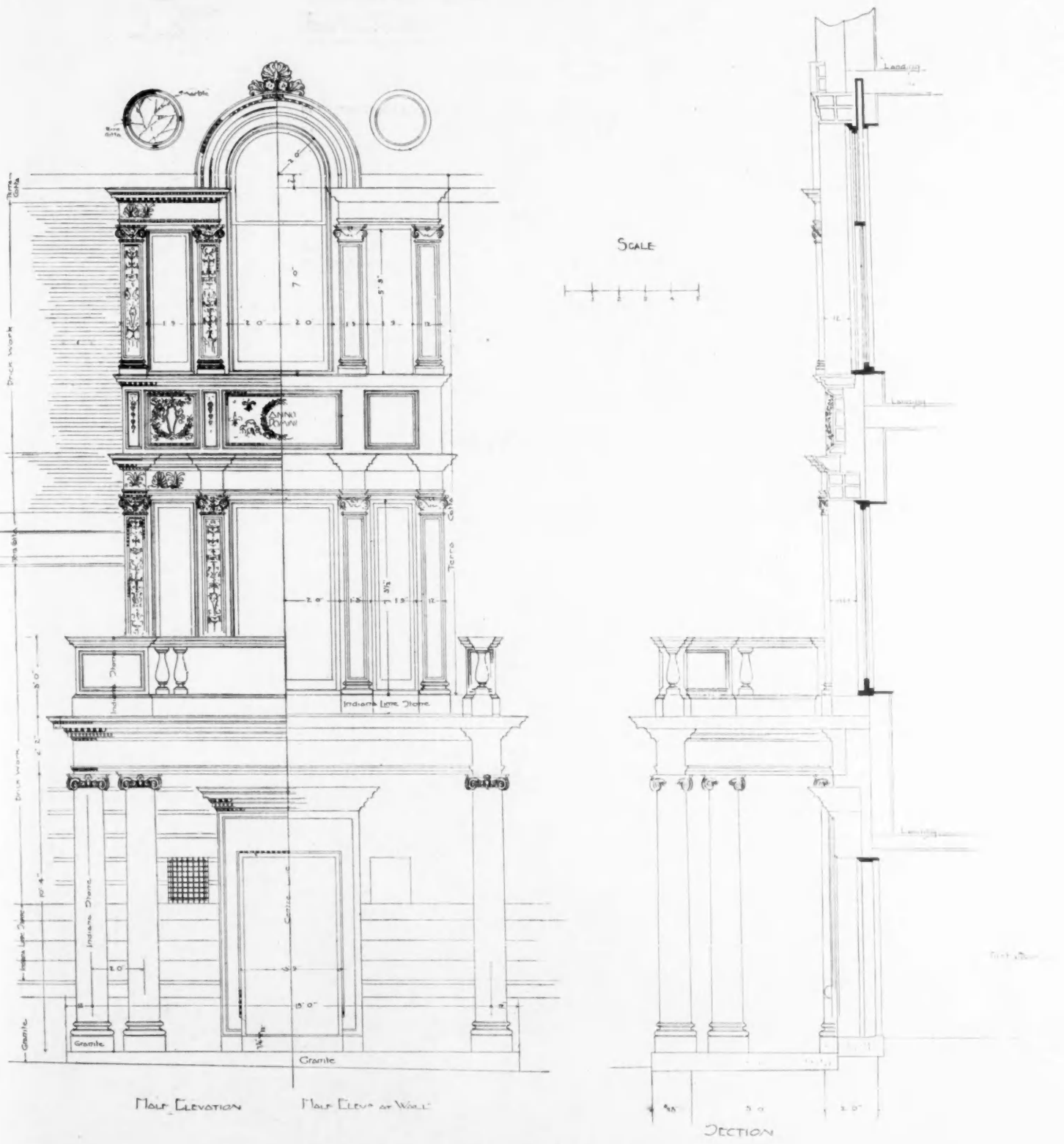
Scale ½ inch = 1 foot.

Scale . Feet



RESIDENCE FOR ROBERT H. FOERDERER, PHILADELPHIA.

HAZELHURST & HUCKEL, ARCHITECTS.



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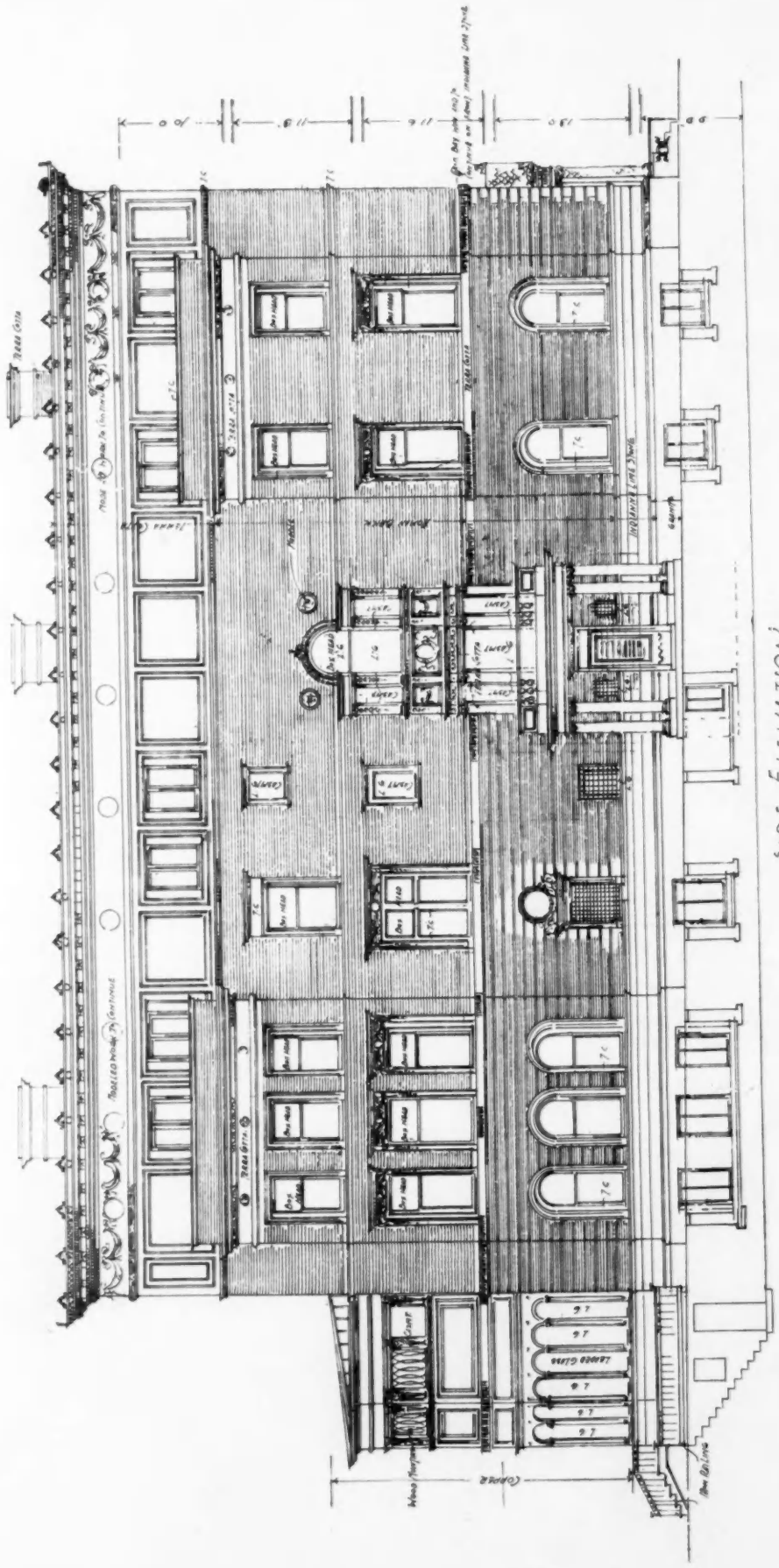
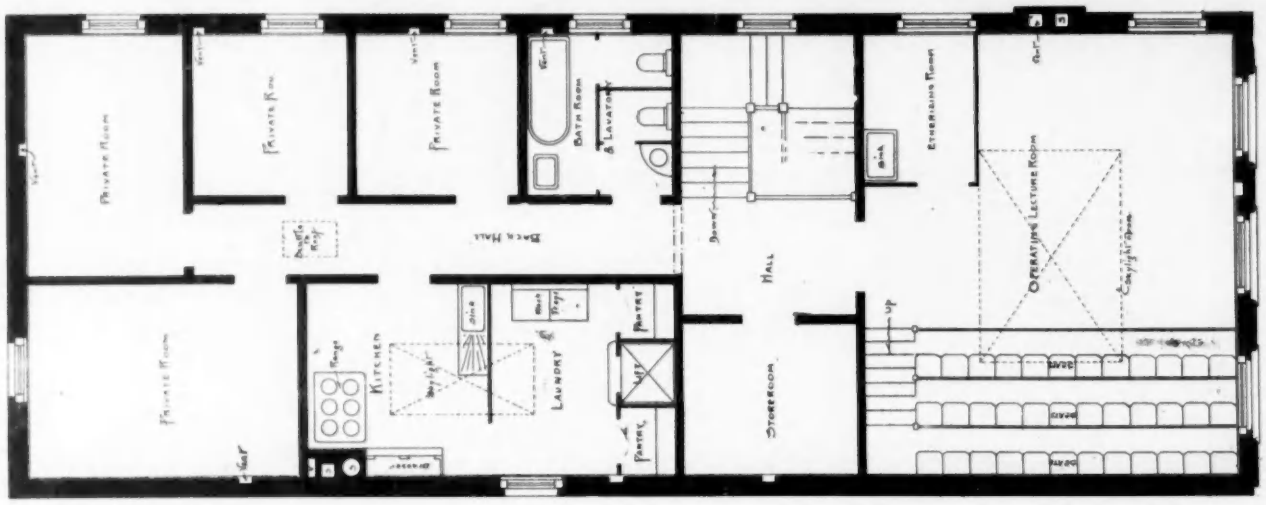


SIDE ELEVATION

RESIDENCE FOR ROBERT H. FOERDERER, PHILADELPHIA.
HAZELHURST & HUCKEL, ARCHITECTS.

FRONT ELEVATION, THE SIBLEY MEMORIAL HOSPITAL, WASHINGTON.
CLARENCE L. HARDING, ARCHITECT.



FLOOR PLANS, THE SIBLEY MEMORIAL HOSPITAL, WASHINGTON.
CLARENCE L. HARDING, ARCHITECT.

THE BRICKBUILDER.

AN ILLUSTRATED MONTHLY DEVOTED TO THE ADVANCEMENT OF ARCHITECTURE IN MATERIALS OF CLAY.

PUBLISHED BY

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No person, firm, or corporation, interested directly or indirectly in the production or sale of building materials of any sort, has any connections, editorial or proprietary, with this publication.

STEEL CONSTRUCTION AND BRICK MASONRY.

WITHIN the past few years a change has taken place in the methods of construction adopted for commercial buildings which is one of the most radical that the world has ever seen, involving not only a complete revision of the theory of construction, but also a reversal of the uses to which some of the materials have been previously put. This change has come as a result of the employment of what is known as the skeleton construction, a system in which the loads of the walls and the floors are all carried down to the ground through steel columns either isolated in the building or built into the thickness of the external walls. In this construction, when carried to its fullest development, masonry as a supporting member counts for absolutely nothing. Brick walls, as such, disappear, and are replaced by screens of brick or stone interposed between the tiers of beams and carried around the steel work, not to strengthen the supporting members, but simply to protect against fire and the elements. So that brick, which was once the fundamental material for building construction, has now simply a decorative or fireproofing function. Of course the vast majority of buildings are now and always will be built in the old method, with solid walls directly supporting the loads, but the increase in the use of the skeleton construction has been so extensive that those who are interested in the manufacture and use of brick as a building material may well ask what has been the influence of the steel construction upon the humbler material.

ACCORDING to the building laws existing in most cities, a brick wall to be carried to the height of the walls in the Manhattan Life Building, New York, would have to be six feet thick. As a matter of fact, the walls of this building in connection with the steel construction are from twelve to sixteen inches thick; so that at first thought it would seem that the skeleton construction has greatly reduced the quantity of brick which would be used in connection with building operations. This is not the case, however. No architect or engineer would dare to build a structure three hundred feet high with walls less than ten feet thick, and consequently such buildings would never have been built except for the skeleton construction; and although the walls may be a great deal thinner than would have been used with the older systems, the results, on account of the extreme heights possible with skeleton construction, show a vastly increased quantity of brick actually employed in building operations. Nor is this all. Brick, on account of the ease with which it is handled and set and the facility with which it can be built into and about the forms of beams and columns, is generally preferred to any other material for both interior and exterior masonry walls of a tall building. Stone is attached with difficulty to the skeleton construction, and is not structurally as satisfactory. Consequently brick and terra-cotta have acted to a very marked degree to drive out stone from tall building construction, so that the quantity which is now used, not only of common brick but of face brick as well, has been greatly increased by the use of the skeleton construction.

WITH the brickwork reduced to the function of a mere fire resistant, or used simply for looks, one would naturally expect the quality of the brick as to hardness to deteriorate. Indeed it is a question whether the extensive use of skeleton construction in some cities has not made possible the manufacture and sale of some notably inferior qualities of face brick. This, however, has not resulted from what could be called the best practice. On the contrary, every intelligent builder knows the absolute necessity of using the very best of brick in connection with steel construction, for the most vital part of the whole system is the endurance against corrosion of the steel itself. Unless the common brick is thoroughly well burned so as to be practically impervious to moisture, there is a great possible, though uncertain, danger to the structure itself, and consequently it is the practice of the best architects to use none but the very hardest and most thoroughly burned brick both in the external surface and for the fireproofing about the columns and beams. Although many inferior makes of face bricks have been sprung on the market and have found too credulous or too parsimonious customers, the extensive possibilities for external brick treatment which the skeleton construction can offer has opened so wide a market for the manufacture of moulded brick, fine qualities of face brick, and the more elaborate terra-cottas, that a distinct revival in burnt clay products might almost be traced directly to the introduction of steel construction. One has only to look over the advertising columns of any trade journal to see what a quantity of firms are engaged in the manufacture of brick and terra-cotta. A dozen years ago architects were tending towards the use of stone. Now the tendency seems to be directly the other way; and that our manufacturers are profiting by it is abundantly demonstrated by the excellent qualities of brick and terra-cotta which are now to be found in the market, which are in every respect far superior to what could be obtained before the steel construction came into use.

Another improvement has operated in connection with brick masonry as a direct result of the use of steel construction. The best experience tells us that the steel is most secure against corrosion when it is imbedded in the best quality of pure cement mortar. Consequently in the better class of work more care is now taken in filling the joints, and brickwork is laid up more solid in a better quality of mortar, than was the case when the walls fulfilled their expected functions in merely resisting dead load, and were made of ample thickness to allow for all the defects which usually accompanied brickwork. In other words, while as a supporting member a great deal less is now demanded of brickwork than ever before, a great deal more is demanded of it as to quality and perfection of mechanical workmanship in the laying. A structure erected in accordance with the best practice observed in the use of skeleton construction to-day affords a better opportunity for the brick manufacturer in both common and pressed brick, gives a better opportunity for the use of decorative terra-cottas, leaves the architect freer in the design of the masonry, uses a great deal more material, and is in every respect better built, more strongly constructed, and more thoroughly knit together than was possible with the system of construction which was used for large buildings a dozen years ago. Brick masonry as a supporting member disappears, and in its place there is a wide range of possibilities opened up for the most varied artistic treatment of clay products to an extent and of a quality which would have been impossible under former conditions.

FLOOR PLANS, THE SIBLEY MEMORIAL HOSPITAL, WASHINGTON.
CLARENCE L. HARDING, ARCHITECT.

FIREPROOFING.

A Department Conducted in the Interests of Building Construction to Prevent Loss by Fire.

FIREPROOF FLOOR ARCHES.

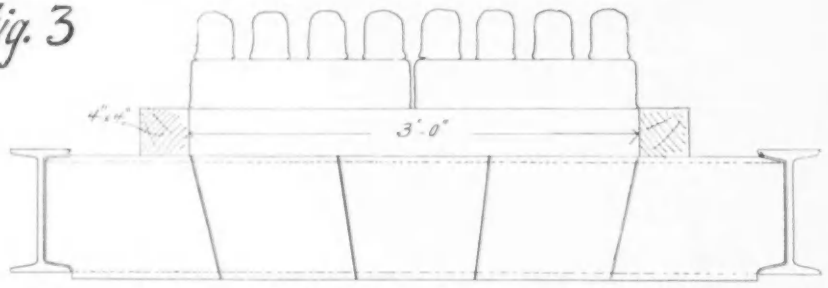
(Continued.)

BY GEORGE HILL, C. E.

PUBLISHED TESTS. — CONTINUED.

THE method of loading was secured by the application of pig iron, as shown by the sketch in Fig. 3, on three inches of sand filling which was placed over the arches, but we do not know whether the pig iron was all on the sand, or part on the sand and part on the wood, although one of the photographs seems to indicate that it was on the sand.

Fig. 3



This does not represent the condition which is actually obtained in the building, in which there is either a couple of inches of good concrete or else the ordinary common cinder filling and the sleepers and flooring. The method of applying the load was such as to make it difficult to destroy arches of high strength, also making it impossible to ascertain how the arch failed, since the mass of pig iron falling on the arch after it reached the ground was likely to smash many of the blocks by the impact, making it impossible to observe on what line the arch failed, losing another opportunity of determining which form of arch gave the most strength per square inch of effective section, and as a consequence which was the most economical from the point of view of the manufacturer. There are two points which should be noted in every test. They are, how the arch failed, and under what load; and any test which falls short of determining these must necessarily fall short of its full usefulness. Impact tests seem to be rather popular, really are of little utility, and simply of value as showing a special feature of one kind of arch material. They need not be further discussed. The fire and fire-and-water tests were unquestionably good so far as they went, but failed in the execution: first, because the stream of water was too small; and second, because the arch lacked its protecting covering of plaster, which under actual conditions it nearly always has. This made the result again open to dispute, raising the question of whether or not they truly showed how the material would act when in use in the building.

Any engineer taking up the general result of the static tests, with a knowledge of the usual practice of allowing a factor of safety of ten for mason work, will be surprised to see that these tests seem to show that the safe loads computed for nine square feet of area are from sixty-four pounds per square foot up to one hundred and seventy-three plus pounds per square foot, with a weight of the material alone of about forty-five pounds per square foot, which, with filling, plaster, flooring, etc., added, amounts to a total of about seventy-five pounds per square foot. When we compare this with the one thousand five hundred pounds strain, claimed by some makers, it is clear either that there is something radically wrong, or that no such factor of safety has been considered necessary by the maker. The subsequent tests will indicate the extreme irregularity of certain of the material, and perhaps afford some light on the subject of the proper factor to use.

When we note how these arches fail, we at once see a new light; those that fail did so at the skew backs. A glance at Fig. 2 will show why, since in each case the details indicate a weakness at the skew-back point, and in some cases an application of the bearing surfaces in such away as to invite exactly the shearing that occurred. If we calculate the shear per lineal foot, we will find that the arches sheared at 170 pounds per lineal foot upwards, which, if the factor of ten were applied, would limit the useful span of arches of this type to about three feet. These arches were tested when practically four days old, and as a consequence the mortar bedding, the skew backs to the beam flanges, even if well applied, was still too soft to prevent concentration of pressure at hard spots, or spots where the tile projected beyond the uniform line. As a consequence it would be possible for incipient failures to occur at one point, and then starting there, travel along the whole length of the skew backs from block to block with great rapidity, causing the failure of the whole mass, like a card house. In the case of the Lee arch, this bedding or lack of satisfactory bedding would not be of such consequence, since the bearing surfaces of each rib amounted to not more than two square inches.

In the Lee arch there were two thousand pounds per lineal foot safely carried, thus showing the crushing strength of the material per square inch to be above two hundred and fifty pounds; the shearing strength of the material was at least fifty pounds per square inch, and both of these results seemed to be very low, in the light of what we know of the compressive and shearing strength of such material.

In summarizing these results we may say that their principal use was to stimulate action in the line of better design of the arch-block section, and to demonstrate the weakness of the skew backs of the old style of construction. I think there can also be traced in the work of the manufacturers of terra-cotta a better design and a better realization of what the loads that the material are to be subjected to actually are.

Kindl Arch. (*Engineering News*, July 4, 1891, p. 3.) This is practically the Wilson arch, as was pointed out in a subsequent communication to the *Engineering News*, but differs from it in having greater depth for the suspending iron straps, and the using of hard-burned fire clay for the compression member instead of the concrete, both of these being decided improvements. It is shown in Fig. 4. The article descriptive of it says: "The practicability of this system was tested in a rude way, by building an experimental floor, as shown in Fig. 4. and loading it to the breaking point; this floor broke with a load of three hundred pounds per square foot, but if the material had been closely laid together, and a sufficient number of straps had been placed in the same, it would no doubt have been good for one thousand pounds per square foot."

This of course is quite evident; the actual safe load on the tile arch was about thirty pounds per square foot, or about that of the weight of the arch itself.

No information is given as to how the arch failed, and we therefore cannot draw any conclusions from the test; it would seem, however, as though too many questions of fidelity of workmanship were involved. Any little carelessness in the putting on of the straps, any improper bedding of the blocks to the straps, any carelessness in the putting up of the fire clay or properly wedging it at the ends, would all be likely to cause serious trouble, while if oxidation set in once it is certain that the small sections of the straps would soon be eaten away.

Cutshaw Test. (*Engineering News*, Nov. 14, 1891, p. 471.) These were made of the Empire Fireproof Construction Company's arches, single and double; the arches being made as shown in Fig. 5. These arches were covered with a thin layer of sand. Test No. 12 was made with a combination load of pig iron and brick; tests Nos. 11 and 13 were made with a load of pig iron alone, set on 1½-inch planks laid on the sand bed; all of the remaining tests were made by piling brick, and all of the loads were uniformly distributed over the area of the arch. The tests extended over a period between Nov. 15, 1890, and June 24, 1891, and are thus summarized by Col. Cutshaw:—

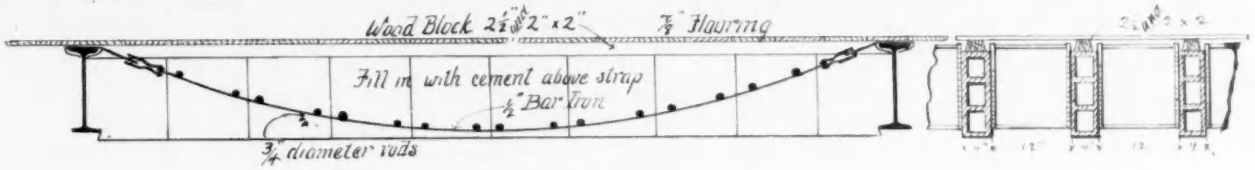


Fig. 4.

TABLE I.

TESTS OF THE EMPIRE COMPANY'S HOLLOW-ARCH BLOCKS LAID IN ROSENDALE CEMENT AND SAND MORTAR MIXED, 1 TO 2.

1st Test. — 6-inch blocks burned to a dark color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 3.95 ft.	Loaded area 9.25 sq. ft.	Set one week before loading.
2,695	291.3	1-3	Slight crack in cement joint underneath at centre.		
4,410	476.7	3-8			
5,551	600.1	5-8	Not broken.		

2d Test. — 6-inch blocks burned to a light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 3.95 ft.	Loaded Area 9.25 sq. ft.	Set one week before loading.
980	105.9	1-12			
2,205	238.4	1-8	Beams spread 1-2 inch at bottom.		
3,675	397.3	5-16			
4,900	529.7	1-2			
5,355	579.		Arch collapsed.		

3d Test. — 6-inch blocks burned to a light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 3.95 ft.	Loaded Area 9.39 sq. ft.	Set one week before loading.
980	104.4	0	Slight crack in cement joint underneath at centre.		Cambered 1-2 in.
1,470	156.5	1-16			
2,205	234.8	1-8	Top flanges of beams approached each other 1-16 in.		
3,675	391.4	3-16			
4,613	491.3		Arch collapsed.		

4th Test. — 6-inch blocks burned to a light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 3.95 ft.	Loaded Area 9.36 sq. ft.	Set 36 hours before loading.
735	78.5	1-16			
1,225	130.9	1-8	Slight crack in cement joint underneath at centre.		
1,715	183.2	5-32			
1,960	209.4	3-16			
2,450	261.5	7-32			
2,695	288.		Arch broken.		

5th Test. — 6-inch blocks burned to a light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 3.47 ft.	Loaded Area 8.81 sq. ft.	Set 24 hours before loading.
735	83.4	1-32			Cambered 5-8 in.
1,225	139.	1-16			
1,715	196.	3-32			
2,205	261.6	1-8			
3,241	367.9		Arch broken.		

6th Test. — 12-inch blocks burned to a dark color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 3.74 ft.	Loaded Area 8.23 sq. ft.	Set 40 days before loading.
950	125.	1-16			
1,782	236.	1-8			
3,089	408.	3-16			
5,352	708.	1-4			
5,352	708.	5-16	After interval of one hour stood 48 hours.		
5,572	736.	3-8			
7,603	1,005.	7-16	Left loaded for 8 days, no further deflection.		

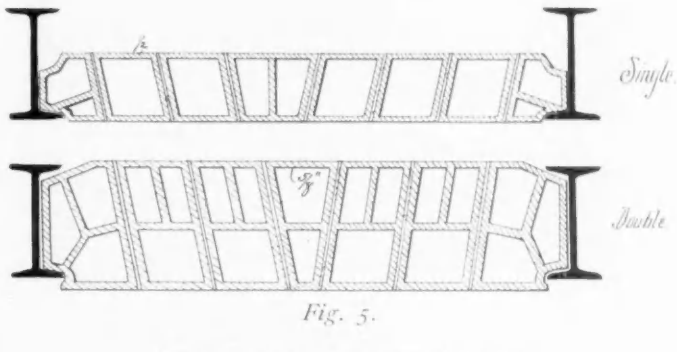


Fig. 5.

7th Test. — 12-inch arch burned to a light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 3.74 ft.	Loaded Area 8.23 sq. ft.	Set 40 days before loading.
4,752	576.	1-16	Deflection increased to 3-8 in. in 24 hours.		
5,950	720.	1-16			
6,415	778.		Collapsed in 4 hours.		

8th Test. — 12-inch arch burned to a very light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 4.37 ft.	Loaded Area 11.45 sq. ft.	Set 20 days before loading.
3,168	227.	1-16	Crack in cement joint at key.		
4,752	415.5	1-8			
6,336	554.		Collapsed in 24 hours.		

9th Test. — 12-inch arch burned to a light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 4.37 ft.	Loaded Area 11.45 sq. ft.	Set 20 days before loading.
3,168	277.	0			
4,752	415.5	1-8			
8,579	749.	1-4	Left on 48 hours.		
10,144	888.	5-16	Left on 48 hours.		
11,412	1,000.		Collapsed.		

10th Test. — 12-inch arch burned to a light color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 4.33 ft.	Loaded Area 11.34 sq. ft.	Set 37 days before loading.
1,180.8	102.	0			
1,771.2	153.	1-16			
2,066.4	178.5	1-16	Slight crack in cement joint, first block next skew back.		
2,656.8	229.5	1-8			
2,952.	225.		Slight crack in joint at key.		
3,542.4	306.	3-16			
4,428.	382.5	1-4			
5,904.	510.	1-4	Crack in key joint increased.		
6,494.4	561.	1-4	Stood with load 15 hours.		
7,084.8	612.2	5-16	Arch broken suddenly.		

11th Test. — 12-inch arch burned to a dark color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 4.33 ft.	Loaded Area 10.83 sq. ft.	Set 10 days before loading.
4,717	436.	1-16			
7,637	705.	1-8			
8,212	758.	3-16			
9,509	878.	1-2	Crack in cement joint second block from skew back.		
9,701	896.	5-8			
11,445	1,057.		Arch collapsed.		

12th Test. — 12-inch arch burned to a dark color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 4.33 ft.	Loaded Area 11 sq. ft.	Set 19 days before loading.
3,590	327.	1-16			
6,442	586.	1-8			
8,442	768.		Collapsed.		

13th Test. — 12-inch arch burned to a dark color.

Total Load, lbs.	Load per sq. ft. lbs.	Deflection, in.	Clear Span 4.33 ft.	Loaded Area 11 sq. ft.	Set 23 days before loading.
2,868	261.	1-16			
6,910	628.	1-3			
8,204	746.	3-16			
9,013	819.	1-4			
9,860	896.	1-2			
10,434	949.		Collapsed.		

Had these tests been accompanied with a note of some kind, as to where the first failure took place, they would have been the most valuable of any published so far as my observation goes, in so far as they determined the actual strength of the arches. Even as it is, by assuming that the sections were practically uniform, and of the thickness given, valuable results can be deduced by calculation from them. This however belongs to a later section.

It is quite evident that the design of the six-inch arch was very bad, but still worthy of note; that the carrying capacity of the skew backs, which are of better design than those shown in Fig. 2, have been much increased. It is also worthy of note that the double arch has come up to a reasonable amount in point of strength; a safe load approximating one hundred pounds per square foot having been attained.

Pioneer Company. (Catalogue.) "End pressure arch of hard tile, Fig. No. 6, shows section of the arch and skew back."

The load per lineal foot of skew back was 1,315 pounds; the failure occurred under the load given on the sketch, generally the whole arch going at once; no special failure of the skew back was noted. The concentration gave 3,287½ pounds per square foot of loaded area, showing a decided improvement in the style of arch.

A second test was made by impact, the log dropping on its side and finally knocking out four rows of an arch of six-foot span and five feet wide. The fifth row, one foot wide of six feet one and one halfinches

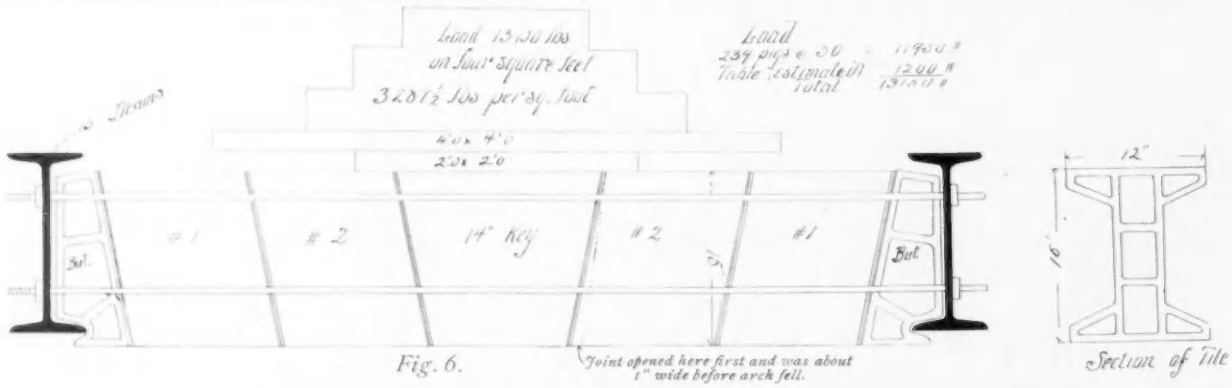


Fig. 6.

The arches were carefully laid on rigid flat centres between I beams securely bolted together, and with joints of about one fourth inch, using shims of same material as arch blocks, where necessary to make close surfaces; and after standing till the mortar had set, a thin uniform layer of sand was spread over the arches, the centre removed and bricks placed on in regular courses till the arches broke. Tests one and six had reached prescribed limits of six hundred and one thousand pounds per square foot without breaking and were taken down. The loads of test twelve were made up of both bricks and pig iron, and of tests eleven and thirteen of pig iron alone with one and one half inch planks laid on the sand bed. These tests ran through a period of about seven months, from Nov. 15, 1890, to June 24, 1891. We may thus summarize the results: —

TABLE II.

Test.	Length along Arch Loaded.	Shear per lineal ft.	Safe Load per sq. ft. Factor of Safety 10.
1	2 ft. 4 in.*	1,190 lbs.	60 lbs. +
2	2 " 4 " *	1,155 "	57.9 "
3	2 " 4 " *	993 "	46.1 "
4	2 " 4 " *	575 "	28.8 "
5	2 " 6 " *	650 "	36.8 "
6	2 " 3 " *	1,700 "	100. " +
7	2 " 3 " *	1,425 "	77.8 "
8	2 " 7 1-2 " *	1,210 "	55.4 "
9	2 " 7 1-2 " *	2,180 "	100. "
10	2 " 7 1-2 " *	1,350 "	61.2 "
11	2 " 6 " *	2,290 "	105.7 "
12	2 " 6 1-2 " *	1,685 "	76.8 "
13	2 " 6 1-2 " *	2,050 "	94.9 "

* Plus or minus.

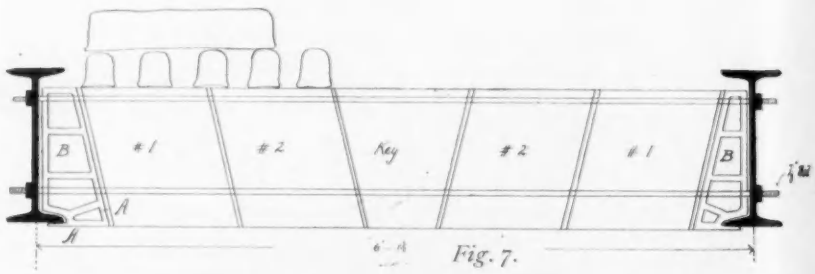


Fig. 7.

span, was left, although considerably jarred; this was then uniformly loaded with pig iron covering the entire area until 4,600 pounds was placed upon it, when the arch failed, the failure occurring first on the left-hand skew back at the point marked A on Fig. 7; the shear per lineal foot was 2,300 pounds, the safe load 76.7 pounds per square foot. This shows somewhat of a decrease from the above, but some allowance must be made, first for the failure of the skew back, which is not of good type; and second, for the shaking up which the arch received under the imposition of the impact test. The tie rods of these arches were but seven eighths inch in diameter, and probably the ends were not upset; no statement is made as to whether or not there was any elongation of the tie rod, but from our own observation we are inclined to think that such was the case to a considerable extent, thus forcing the concentration of pressure on a point which led to the failure.

(*To be continued.*)

MORTARS AND CONCRETES.

A Department devoted to Advanced Methods of using CEMENTS and LIMES in Building Construction.

AMERICAN CEMENT.

III. — *Continued.*

Smeaton, in his "Narrative of the Eddystone Lighthouse," says: "It remains a curious question which I must leave to the learned naturalist and chemist, why an intermediate mixture of clay in the composition of limestone of any kind, either hard or soft, should render it capable of setting in water in a manner no pure lime I have yet seen, from any kind of stone whatsoever, has been capable of doing. It is easy to add clay in any proportion to a pure lime, but it produces no such effect; it is easy to add brick-dust, either finely or coarsely powdered, to such lime in any proportion also; but this seems unattended with any other effect than what arises from other bodies becoming porous and spongy, and therefore absorbent of water, as already hinted, and excepting what may reasonably be attributed to the irony particles that red brick-dust may contain. In short, I have as yet found no treatment of pure calcareous lime that rendered it more fit to set in water than it is by nature, except what is to be derived from the admixture of trass, pozzuolana, and some ferruginous substance of a similar nature."

It would seem that this description by Smeaton, as to the action of pure limes, coupled with his discovery as to the hydraulicity of impure ones, ought to have annihilated the ancient fallacy, but it did not.

Quoting again from Burnell: "Some curious facts might be mentioned, not only to show the influence of a large body of masonry in retarding the solidification of the mortar in the interior but also of the danger of using rich limes in cases where such masses are necessary. Amongst them we may mention a fact cited by Gen. Treussart, who had occasion to demolish in the year 1822 one of the bastions erected by Vauban in the citadel of Strasburg in the year 1666.

"In the interior, the lime after these 156 years was found to be as soft as though it were the first day on which it had been laid. Dr. John mentions that in demolishing a pillar nine feet in diameter, in the church of St. Peter at Berlin, which had been erected 80 years, the mortar was found to be perfectly soft in the interior. In both cases the lime used had been prepared from pure limestone."

It is not known whether these lime mortars were made by an admixture of sand, burnt clay, trass, or pozzuolana with the lime, but, so far as results are concerned, they would have been the same, for nothing is more certain than that pure lime, with or without admixture of any one or all of the materials named, cannot be induced to harden by simple mechanical mixture of these substances whether in air or water. It never has done so and never will. If fat lime can be made to assume an hydraulic character, by its admixture with pozzuolana, why did Smeaton seek further? He had the rich lime and he had the pozzuolana. Why did he not use them if he believed in the tradition that had been handed down through the centuries,— that such a combination, although purely mechanical, would harden under water?

If he believed that the Romans used this material in all their wonderful hydraulic cement constructions, why did he hesitate for a moment even? The answer is plain. Simply because he tried it in every conceivable way, as he himself states, and found it was not true, that such a mortar would harden under water. That is why he sought further. And yet, all who write of Smeaton, on the subject of his great discovery, while acknowledging that he found the ancient theory false, insist that the public shall deem it true.

It is quite true, that rich lime, or even hydraulic lime, takes very kindly to burnt and powdered clay, pulverized bricks, trass, or pozzuolana, all of which are substantially one and the same thing, the latter two, however, being of volcanic origin. No one of them contains inherent hydraulic qualities, and their mechanical incorporation with rich lime can in no manner render the latter hydraulic.

Although Smeaton used pozzuolana with the Aberthaw hydraulic lime in the construction of the Eddystone Lighthouse, yet it is doubtful if he would have done so had he not "fortunately found at Plymouth (where he was cutting and fitting the stones for the lighthouse) a considerable quantity of this material which a merchant had imported on speculation, expecting to sell it to the constructors of old Westminster bridge."

Henry Reid, in his work on "Portland Cement," London, 1877, states, "The Aberthaw lime in itself could have accomplished all he" (Smeaton) "desired, for he had unlocked the mystery of hydraulicity, and felt confident in the knowledge of its cause."

The composition of trass and pozzuolana will be found in the table of analyses.

Although Smeaton had discovered during the winter of 1756–57 that certain strata in the blue lias formation would, after calcination, produce an excellent hydraulic lime, it appears that he only made use of layers containing clay in such proportion as to cause his manufactured lime to slake by hydration.

It is very probable that he calcined some of the lower layers, but, finding they did not slake readily, confined himself to the use of such layers as would do so.

The idea of pulverizing such layers as would not slake readily, then testing them, and forming thereby a very energetic hydraulic cement, did not occur to him; and this is probably the point referred to by Burnell, wherein he states, as already quoted, "An illustration of the ease with which a very acute observer may stop short on this side of the attainment of a great truth."

In 1786 De Saussure found that the lime of Chamouni set under water, and, like Smeaton, attributed this faculty to the presence of clay.

Mr. Parker, of London, in the year 1796, took out a patent for the manufacture of what he called "Roman" cement from the septaria modules of the London clay formation found in the Isle of Sheppy.

This septaria was natural cement rock, and after calcination it was reduced to powder in mills suited to the purpose. This was undoubtedly the beginning of the natural rock cement industry in modern times. Its introduction by Parker was soon followed by its manufacture from the blue lias formation, and it went into general use throughout England.

Reid says, in speaking of Parker's Roman cement, "The Thames tunnel could not have been made but for the advantages it secured, and many of the early railway tunnels were built with it as a cementing agent."

Burnell, so late as 1868, in his work on "Limes and Mortars," states in regard to Roman cement, "Almost all of the works executed in water in England at the present day are executed with it."

In 1802 natural cement was produced at Boulogne, France. The rock at Boulogne is in the form of septaria, and is sometimes called "Boulogne pebbles." Its proportions of clay and carbonate of lime are such that it is used for the production of natural Portland cement.

In 1810 Edgar Dobbs, of Southwark, London, obtained a patent for the manufacture of artificial hydraulic lime or cement, by mixing together in suitable proportions carbonate of lime and clay, and after

drying, he moulded or cut it into pieces before burning. He then states that "the burning must be sufficient to expel the carbonic acid from the lime without vitrifying any of the substances."

This is the first record we have of the production of artificial cement, or, as it was then called, "artificial hydraulic lime."

From 1813 to 1818 the artificial hydraulic limes were produced in France by M. Vicat, and by Dr. John of Berlin, and Raucourt de Charleville in Russia.

In 1824 one Joseph Aspdin, of Leeds, England, obtained a patent for the manufacture of an artificial cement which, in his specifications, he designated as "Portland cement."

This being the first time the word "Portland" was ever coupled with, or in any way mentioned in connection with cement, whether natural or artificial, there is no doubt whatever that Mr. Aspdin is entitled to the doubtful distinction of inventing the term, for certainly it is a most absurd and meaningless word so far as it relates to hydraulic cement.

Mr. Parker, on the other hand, had ample justification for naming his product "Roman cement," for he had but reproduced a cement substantially identical to that used by the Romans 1800 years before, and it is to be deeply regretted that the title he then employed did not thereafter cling to the natural rock cements the world over.

URIAH CUMMINGS.

(To be continued.)

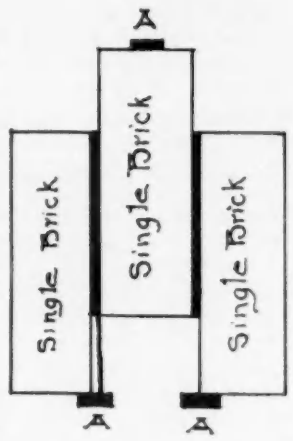
SHEARING TESTS OF MORTAR.

WHILE tests on the tensile, compressive, and transverse strengths of mortar are made in innumerable quantities every year, our knowledge of its shearing and adhesive strengths is somewhat meagre; and yet, whether the shear occurs through the body of the mortar or by sliding on the joint (whichever is the weaker of the two), a knowledge of the power required to cause this action must be always valuable and often needed.

With this end in view, experiments have been made by the author in the laboratories of McGill University on this subject.

The method of procedure was as follows: —

Three bricks were laid in mortar and tested, on end, as in the accompanying sketch. It was found necessary to place soft wood bearings at A, A, A, in order to do away with the transverse action, which tended to open out the joints; when this was done the action set up was practically a pure shear. In all, fifty-two tests were made on lime mortar 1 to 3 by weight, soft mortar; on natural cement mortar 1 to 1 1-2 by weight, 18 per cent water; on Portland cement mortar 1 to 3 by weight, 15 per cent water.



The mortars stood the following ordinary tests (see Table A).

The sand specimens were tamped lightly into the moulds, and were therefore quite near to practice in method of setting.

The following shearing results were obtained (see Table B).

In connection with these tests, experiments were made to determine the coefficients of friction between the surfaces after they had sheared. These were found to be: —

Lime-mortar surface on lime-mortar surface . . .	.39
Natural cement mortar on brick surface	.40
Portland cement mortar on brick surface	.35

So that we are now able to determine some facts on the question.

The first one regarding lime mortar is that at one month old, at least, the adhesion is greater than the shearing strength, as in almost all cases the mortar sheared through at an average of ten pounds per square inch, regardless of the surfaces or thickness of joint, this being one third of the tensile strength at the same age, and one tenth of the compressive strength at the same age obtained on two-inch cakes and one-inch tension pieces.

Coming to the cement mortars we notice that —

1. The naturals are stronger in air, and the Portlands in water.

2. That the ratio of strengths in water, $\frac{13}{2}\frac{9}{7}$, is exactly the same as tensile strength under water at the same age, *i. e.*, $\frac{13}{92}\frac{2}{2}$.

TABLE A.

	Sp. Gr.	Time of Set. Incip.	Time of Set. Full.	Residues per cent. 50 Sieve.	Residues per cent. 80 Sieve.	Residues per cent. 120 Sieve.	Tensile Strength. Neat. 3 days.	Neat. 1 wk.	Neat. 4 wks.	1 1-2 to 1. 1 wk.	1 1-2 to 1. 4 wks.	3 to 1. 1 wk.	3 to 1. 4 wks.	Compressive Strength. Neat. 1 wk.	Neat. 4 wks.	1 1-2 to 1. 1 wk.	1 1-2 to 1. 4 wks.	3 to 1. 1 wk.	3 to 1. 4 wks.
Lime												20	30						102
Natural Cement .	2.96	45′	2° 45′	2.9	11.7	21.4	99	150	268		132			1285	2255	250			
Portland Cement .	3.10	1° 0′	5° 0′	0.6	5.5	13.2	278	399	459			43	92	1362	2492			341	

TABLE B.

TABLE OF SHEARING TESTS OR MORTAR ADHESION TO BRICK SURFACES (IN SHEAR).

Kind of Mortar.	Joint.	Brick.	No. of Tests.	How Indurated.	Shear in lbs. per sq. inch. Average.	Least.	Greatest.	Remarks.
Lime 1. Sand 3 . .	1-4″	A	5	In air.	9.7	8.4	11.9	All sheared through the mortar.
" " . .	1-2″	A	4	"	12.1	6.1	19.8	" " " " "
" " . .	1-4″	B	5	"	12.0	9.1	15 5	" " " " "
" " . .	1-2″	B	5	"	8.0	5.5	11.0	All came away from brick (mortar dry).
Natural Cement 1. Sand 1 1-2	1-4″	A	5	"	22.3	8.0	32.1	" " " " "
" "	1 2″	A	5	"	29.0	24.0	33.0	" " " " "
" "	1-4″	B	5	"	75.0	25.0	118.0	2 came away from brick, 3 sheared.
" "	1-2″	B	3	"	85.0	43.0	118.0	1 " " " " 2 "
" "	1-2″	B	3	In water.	38.0	34.0	42.0	All came away from brick.
Portland Cement 1. Sand 3 . .	1-4″	A	3	In air.	10.6	10.2	11.6	" " " " "
" " . .	1-4″	A	3	In water.	13.0	10.2	16.4	" " " " "
" " . .	1-4″	B	3	In air.	16 5	9.2	24.2	" " " " " The brick which was on top in the original laying always sheared 1st and at a less load than that of lower one, which, of course, set under twice as much load, or pressure.
" " . .	1-4″	B	3	In water.	27.1	20.2	36.9	" " " " "

A. Common, flat, unkeyed salmon brick.
B. La Prairie pressed brick, key on one side.

3. That the pressed bricks keyed on one side only give higher results than common bricks, and therefore that the adhesions to a pressed-brick surface on which the shears took place are higher than to ordinary brickwork.

4. The average of three natural cement tests which sheared through mortar was one hundred pounds per square inch, giving the true shearing strength; if the bricks had been keyed on both sides, no shears could be obtained through the Portland cement mortar.

5. Tests made on specimens kept in air showed conclusively the superiority of rich, natural cements for this kind of work, which is usually in air, over Portland cement mortars with a *heavier* dose of sand.

It was found that mortars must be very soft to give the best adhesive results, but this is probably old history.

With such facts as the above at hand, using the coefficients of friction obtained above, we can estimate fairly well what resistances such surfaces will offer against one course sliding over another.

Because this action seldom takes place is no reason for disregarding it; on the other hand, a knowledge of such points may enable us at times to economize in our design by counting in this adhesion along with our friction, which is usually looked to, to prevent sliding one course of masonry over another.

CECIL B. SMITH, MA. E.,
McGill University,
Jan. 15, 1895. Montreal.

SAULT STE. MARIE, MICH., Jan. 31, 1895.

EDITOR OF THE BRICKBUILDER, Boston, Mass.

Sir, — Without wishing to criticise the valuable article of Mr. Fred. T. Hodgson, C. E., on "Concretes, Cements, and Mortars: Old and New," which so abounds in practical hints, it may be of interest to call attention to a few points which appear to admit of question or require some explanation. It seems probable that in the very commendable effort to put a large subject in a small space, Mr. Hodgson may have left erroneous impressions on some of those readers of THE BRICKBUILDER who have not had time to look into the subject of cements very thoroughly, but who are, nevertheless, glad to receive such concisely stated information on the subject as Mr. Hodgson presents.

In the last paragraph of his article in the December number the inference would seem to be that two hundred and fifty pounds per square inch for briquets of neat Portland cement at the age of seven days is a high requirement. The present writer does not know of an English "standard," but turning to some of the best authorities on the subject we find that even as long ago as 1870, Mr. John Grant required three hundred and fifty pounds per square inch at seven days on the London Main Drainage Works. In 1890 Mr. Henry Faija, who was an eminent English authority, recommended three hundred and fifty pounds, and in 1893 he recommended three hundred and fifty to four hundred pounds per square inch. Mr. Maclay, of the New York Department of Docks, specified three hundred pounds per square inch in 1891, and many specifications require from three hundred and fifty to four hundred and fifty pounds per square inch.

On page 17 of the January issue the statement that the finest ground cement is the heaviest may be due to a misprint. Fine grinding of course lessens the weight per cubic foot.

The ratios given for the strength of various sand mortars to the strength of neat cement mortar may apply for short-time tests, or for a poor quality of cement or sand. Combinations of good sand with good cement give better relative results than are shown in the table of Mr. Hodgson. Conclusions drawn from the experiments of others are given in the following table in connection with those stated in the paper. The ratios are only approximate of course: —

Parts Sand to one of Cement.	Ratios of strength of Mortar to the strength of neat Cement Mortar.					
	F. T. Hodgson, C. E. Proportions by Volume.	John Grant, Proportions by Volume.	E. C. Clarke, Proportions by Volume.	I. O. Baker, Proportions by Volume.	Annual Report for 1893 of Col. O. M. Poe, Corps Eng'rs, U. S. A. Proportions by Weight.	Gen. Gilmore, Results at 1 year.
0	1	1	1	1	1	1
1	1-2	3-4	3-4	3-4	1	2-3
2	1-3	1-2	2-3	3-5	3-4	2-5
3	1-4	1-3	1-2	1-2 nearly	1-2	3-10
4	1-5	1-4		1-3	1-3	1-5
5	1-6	1-6	1-3 nearly	1-4	1-4	1-8

The statement on page 18 that "cements that set quickly in air harden slowly under water, and should not be used in such positions," is a very remarkable one. There are special reasons for using a quick-setting cement for submerged work. It is true that it is the general opinion that the ultimate strength attained by a quick-setting cement is less than that attained by a slow-setting one, but the advantages in the use of the former frequently outweigh the objection. *Extreme* activity is undesirable for obvious practical reasons as well as from the fact that cements that set in a very few minutes are apt to be defective.

That "all good cements require to be used immediately after mixing, or they will set on the mortar board and become useless"; and that "poor cements may stand longer, as they do not set so quickly," are also statements that would seem to require modification The author cannot mean that all good cements set "immediately," since he has said that cements that set quickly in air should not be used under water. Some cements which set in from twenty to thirty minutes and are thus "quick setting" are good, and on the other hand "good" cement may take from five to ten hours to set. It is also a fact that the opinion is gaining ground that mortar of moderately slow-setting cement may be left sometimes on the mortar board and remixed before use without injuring it, though of course this treatment is very liable to abuse.

L. C. SABIN.

BELOW we give the address of Mr. Robert Bevan, chairman of the meeting recently held in London by English manufacturers of Portland cement, for the purpose of forming an association to prevent he adulteration of cement.

In addition to Mr. Bevan's address, we print extracts from the remarks made by Mr. Leedham White, a prominent English manufacturer of Portland cement.

Mr. ROBERT BEVAN. *Gentlemen*, — This meeting of cement manufacturers has been convened, not for the purpose of debating whether an association should be established, yes or no; you may take it that virtually an association is established to-day. Of course, those who form this association will be exceedingly glad to welcome every cement manufacturer who is prepared to join the association, under certain conditions, and those conditions I will explain presently. There may be differences of opinion amongst some of you. I dare say there are. I should judge that there are from the tenor of the correspondence that has come from the different cement manufacturers to Messrs. Renshaw, Kekewich & Smith, who convened this meeting. One or two of you have thought that the Chamber of Commerce of London would be the proper association; but I would just answer that suggestion by suggesting to those gentlemen who took that view that if the Chamber of Commerce had been desirous or competent to deal with this special subject which is under consideration, why have they not already done it? I really do not know what the names are of the members forming the Cement Committee, as I think it is called, of the London Chamber of Commerce; but it is just possible that they may be even members who have lent themselves to the practices which we reprobate. We, however, think it exceedingly desirable that this

association, the purpose of which is single and restricted to one particular object, should be composed of those members of the trade who have utterly clean hands. We do not want to take advice in regard to the ulterior proposals that may be suggested for putting a stop to this very dangerous and inexpedient practice of adulterating. We do not propose to be associated with those who have not an entirely clean slate. It has been suggested — I think it was suggested in one of the public prints, but at all events it has been suggested among some who take a very great interest in this matter — that it would be desirable and absolutely necessary that those who become members of this association should be willing to sign a statutory declaration, taken before a commissioner of oaths, and I will read you the form of the statutory declaration which is suggested: —

"I, So-and-So, managing acting partner of the firm of Messrs. So-and-So; and I, So-and-So, resident manager of the cement works of Messrs. So-and-So, situate at" : or in the case of a company, —

"I, So-and-So, managing director of such and such a company, and I, So-and-So, resident manager of the cement works of So-and-So, situate at So-and-So" (and where there is a limited company having several works it would be necessary that the managing director and the foreman or manager of each separate works should sign) "do solemnly and sincerely declare, that I am well acquainted with the practical manufacture of cement as carried on by the said firm or company, and that, according to the best of my knowledge, information, and belief, the said firm or company have not on any occasion, during the last three years, or within my knowledge at any other time, brought to and added to the calcined product of the kiln, in passing through the crushers or millstones or grinding machinery, or any other subsequent process, a separate supply of raw Kentish rag stone, other stone, furnace or oven ashes, disused or exhausted fire bricks, or any other material, so that such added material would be ground, sifted, or mixed together with the cement, and form part of the cement powder, and sent out and sold the cement in this state. And I make this solemn declaration, conscientiously believing the same to be true, and by virtue of the Statutory Declarations Act, 1835."

Now, gentlemen, of course, I am not going to suggest to other people to do what my firm are not willing to do, and have not done. There (*producing a document*) is our statutory declaration signed by our managing partner, Mr. Edmund Beven, and signed by Mr. James Weeks, the resident manager of our cement works. Now, of course, some gentlemen, I can readily understand, will rather object to sign this. Then, gentlemen, they are not eligible to be members of this association, that is all. Those who can sign it, I rather suspect, will sign it; but those who cannot sign it — of course I do not at all wish to say positively that every one who can sign it will, but I rather suspect that they will; but whatever view will be taken about signing this declaration, it is not a question for debate, because there are those who are willing to sign it, and, therefore, that is an association. But those who take a different view and think that something else ought to be signed — either that it may be permissible to mix these matters — and I understand from conversation that has taken place that there are one or two manufacturers who think it very permissible — if that be so, why, they can have another association, and they may call it what they like. It may be an Association for the Propagation of Adulterated Cement (*laughter*) or any other association that they please; but you will see from the way in which I have put it to you, that it is not between you and those — between any of you and others of you who are willing to become members of this association — it is not a debatable subject, whether or not an association should be formed, or whether or not if an association is formed this declaration will have to be undertaken. That, you see, is a settled matter, and that we do not debate. Then, of course, it may very properly be said by gentlemen here, "Well, but this comes upon us rather suddenly, and you know our Board of Direction does not meet for a few days, and we are individual members of the board, and we must take the authority of our board for the decision that we come to." Well, nothing can be more reasonable than that. Of course, this meeting will have to be adjourned. I can easily conceive that there are several and I trust a good many — and I trust all of us — who will be able to sign this declaration, and who are therefore eligible; but there may be a good many who cannot give a definite answer to-day, not being instructed by their board; and therefore nothing can be more reasonable than that there should be an adjournment of this meeting. But the purpose of an adjournment of this meeting is only to receive the signatures of those who will sign this declaration, and it is not at all for the purpose of debating whether it is an expedient thing, — whether you think it is for the advantage of the trade, or for the disadvantage of the trade. It is settled that there will be an association, and it is settled that no one will be a member of this association who cannot, under a statutory declaration, make this statement. I have told you that my firm have signed it; therefore, I think, at the present time, very little more remains to me than to invite the gentlemen who are able, without consulting their boards, or who are in a position to say that they are prepared to become members of this association on these terms, to express their willingness to sign. There is a gentleman here, a commissioner to receive oaths (*laughter*) who will be happy to take the statutory declararion (*laughter*) of any gentleman who would like to sign; so that you see everything is in an exceedingly businesslike shape, and in a forward state. I have no doubt that there will be some who will be quite willing to sign.

Mr. LEEDHAM WHITE. I wish it to be understood that I am not here to blow my own trumpet, or to advocate or push the firm of J. Bazley, White & Brothers; I am here speaking, as one who wishes to speak straightforwardly of what I know about the trade in general. Of course, this refers to the export trade. Now, my experience of the export trade, as the largest shippers of the article, leads me to exactly the opposite conclusion. I believe, on the contrary, and I say so, as having recently come from one of several visits to the United States, that the stress of competition, especially competition with these inferior foreign brands of natural cements, which are not really Portland cements at all, has put English firms on their mettle, and that not only we, but many other English manufacturers, who send cements all over the world, are actually sending even better qualities than we did a few years ago. I think it is most unfortunate, to say the least, that such statements, which are absolutely devoid of all foundation, should go forward at the present juncture to the public. I admit, gentlemen, that we have been distanced by German skill, and German competition, which is a different thing. I am most anxious that we should not be debarred from imitating German skill, — but that is the next point for us to consider, — because we have much to learn from the Germans. Otherwise, as I say, I came into this room in no hostile spirit to this proposition, and to what I supposed were the objects of the meeting, but rather prepared to indorse them. But whereas, on the face of that circular, it was impossible to read any other meaning in it, than that we were invited to come to this room to confer together as to the founding of an association, we are now asked to join an association which it is said has been already founded. Founded by whom, I should like to know? Any three tailors in Tooley Street might get up an association, and ask others to join it. We intend to join no association without very careful inquiry as to what lines that association intends to go on, because we do not want to be debarred, as people who intend to make progress in every shape and way, from taking advantage of scientific research. When I came into this room this afternoon I was perfectly ignorant as to this matter of Kentish rag stone, except from comparative hearsay, inasmuch as not a ton nor an ounce of that material has ever been used in any one of the four works under the control of J. Bazley, White & Brothers.

THE COTTON STATES AND INTERNATIONAL EXPOSITION COMPANY, Atlanta, Ga., intend to build in the grounds over "Clara Meer" a decorative concrete arch one hundred and fifty feet long. Plans from Mr. Fr. von Emperger, New York, are under consideration.

THE MASON CONTRACTOR.

A Department conducted in the interests of the Builder, and the Contractor for Brickwork.

ORNAMENTAL BRICK ARCHES.

IT often becomes necessary for the mason to cut his own arches, especially in the smaller buildings, and to do this correctly he should have a thorough knowledge of the manner in which to proceed. Of course in many of the larger structures the arches come on the job already cut, and all the mason has to do is to pick out the numbers and proceed to putting them in; but even if these ready-made arches are used, it is always best for the mason to know how to draw and cut his own.

The bricks used in these arches always show their thickness or edge in the face of the wall, which thickness generally being the full width of the brick at the extrados or outside of the arch, and diminishes toward the soffit or inside. This splay is termed the "sommering" of the arch.

The bricks used in external arches should be cut and rubbed with great care to the necessary wedge-like form, according to the gauges or regularly measured dimensions. This is not always done. Bricklayers are generally allowed sufficient time to rub the *outside* of each arch brick properly, so that their work may have a handsome appearance to the eye, but often slur over all the other parts of the work which are hidden from view. Hence in order to save time they are very apt to cut away the inside of the bricks of their arches to such a degree as may even deprive them of their proper wedge-like form everywhere except at the external surface. This neglect produces cracks, and causes the arch to bulge forward, and may even cause one of the bricks of a straight arch to drop down lower than the soffit at bottom of the arch, which defects may be frequently seen over the windows of many brick buildings. It is well known that all ornamental arches generally are nothing more than mere shells, as far as strength is concerned, and support only a portion of the outside of the wall. But if properly executed, well cut, rubbed, and set, they answer the purpose for which they are designed. It is therefore necessary that the mason should know this branch of the trade thoroughly.

Subjoined I place before him the forms of the principal brick arches in use throughout this country, and when he is called upon to construct any of these in practice, all that is necessary for him to do is to apply the rules for designing them as laid down here.

Every mason should have a pair of compasses, a T square, a set square, a drawing board, and his rule, and practise the drawing of these arches he is often called upon to construct.

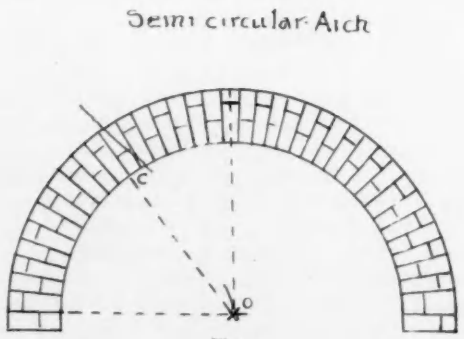


Fig. 1.

To draw and build a semicircular arch, place the point of the compass at the centre *O*, and with the radius *O C* describe the inner circle, which will answer for the soffit (see Fig. 1), then with the same centre describe the outer circle according to the depth required. The number of courses in a semicircular arch is determined by finding how many thicknesses of a brick (the kind to be used) are required at the extrados of the arch, allowing for the thickness of the joint, which is generally one eighth of an inch for pressed brick, and from these points of division drawing to the centre of the arch will determine the splay, and give the rule for rubbing the brick to their proper form. It must be remembered that all *bonded arches* must be spaced off into an odd number of courses, and the proper way to do this is to lay out the *key brick* first, divide it in the centre of the perpendicular line, from which space downwards to the springing line of the arch, making the number of spaces alike on both sides. The soffit line for the brick of the arch is got by placing a set bevel across the space occupied by one course of brick on the soffit line; this is reversed for the brick on the extrados line.

The segment arch may be worked in the same way as the preceding one, the only difference being in taking the centre line to strike it with. This is taken in the perpendicular line below the span, with radius according to the rise required, and this is the point to which all lines must be drawn, both to get the skew back, also the size of the course. (See Fig. 2.)

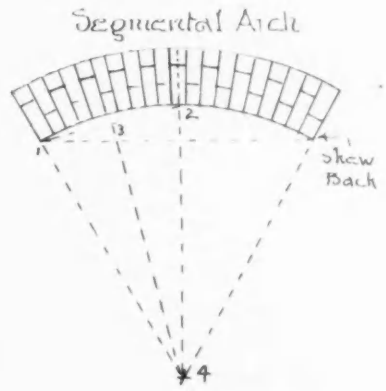


Fig. 2.

Draw the tangent line 1 2, bisect it at the point 3 at right angles with the line 1 and 2, which gives the line 3 and 4, the intersection of which with the perpendicular gives the centre from which the segmental curve of the arch is drawn, and also the point from which all the joints of the arch must radiate.

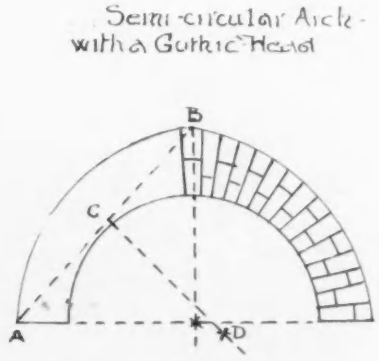


Fig. 3.

Semicircular Arch with Gothic Head. — To draw the outside portion of this arch, it is necessary to draw the line *A B*, bisect it at *C*, draw a line with the set square from *C* (see Fig. 3) at right

angles with *A* and *B* to any point *D*, and upon this line the centre is taken to describe the outside curve of the arch according to the haunch required; and the inner ring must be divided in the same manner as the outer ring of the semicircular arch, but the bevels for the tops must be taken separately. If the depth of the arch be very deep, this inner circle must be so divided that the joint at the outer circle may not be too large.

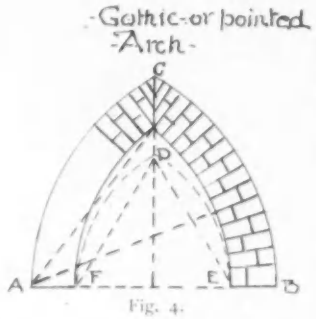


Fig. 4.

The Gothic or Pointed Arch. — (See Fig. 4.) Set out with the width of the arch *A B* on the horizontal line, then with *A* for centre and the distance *A B* for radius, describe the arc *C B*, then with *A E* as radius and with the same centre describe the inner arc *D E*; this forms one side of the arch; then with *B* as centre and same radius used for first half, describe the second. It will be observed that this is not the equilateral Gothic arch, which is shown, however, by the dotted lines within the pointed arch, and described by using the centre *E* and *F*, and is built as follows according to the pointed Gothic: Divide the extrados into courses according to the size of the bricks, and draw the lines to the point *A* as shown, taking care in dividing out the courses that half a course shall be on each side of the perpendicular line at *C* to answer for key brick. The bevel once set will answer for the whole of this arch, the same as semicircular. The mason should observe with attention the manner in which this arch is keyed, for in practice pointed arches are often botched in a ridiculous manner in this respect, simply because the mechanic did not know how to design it or was not allowed time to execute it properly. The best way is to draw the full size of the arch to be constructed first, form your moulds, cut and rub your brick to them, then, when everything is all right, put in your arch as quick as possible.

Sometimes the Gothic arch is cut as represented in the following figure (see Fig. 5), but it is very seldom, on account of the extra work in soffiting the bricks, for in this case each course must be cut to a separate bevel, and the lines for each course must be drawn from the centre *O*.

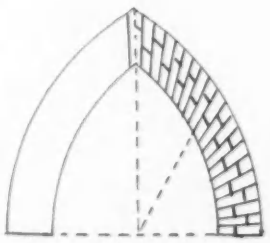


Fig. 5.

Modified Gothic. — (See Fig. 6.) To cut this arch it is necessary to draw the lines *A B* and *B C* at *D* and *E*, and from these points of bisection draw the lines to the points *F F* with the set square, and upon these lines the points are taken to describe the arch according to the depth required. The extrados is then divided into courses and lines drawn to the points *F F*, for the wedge shape of the brick if the arch is to be cut, in the same way as the Gothic arch; but if it is to be *keyed* in with an upright key, the lines must be drawn to the centre *O*.

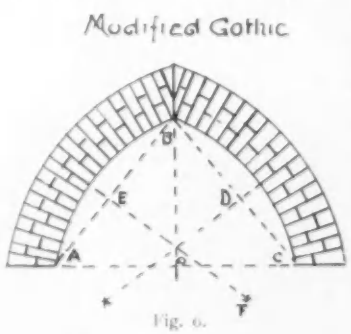


Fig. 6.

Segment Gothic. — (See Fig. 7.) To draw the segment Gothic, lay out the span *A B*, and describe the soffit from the perpendicular line according to the rise required as at *O*, the extrados of the arch is obtained as shown for the *modified Gothic*. Care should always be taken in laying out the courses of this arch that the key may appear as shown in the cut. The wedge-shape form of the brick is obtained from the centres *C C*. The soffit and cross joints are obtained from the centre *O*, but the extrados line of the arch must be cut from the centres *C C*, also the line of skew back.

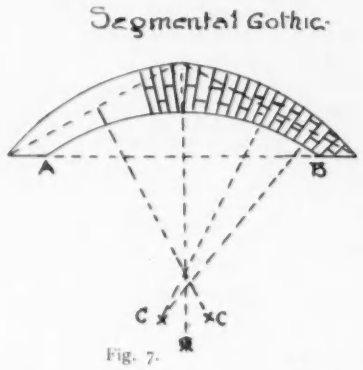


Fig. 7.

Camber Arch. — When the curve of the segmental arch is very flat, the centre from which it could be described is very distant from the intrados of the arch, the brick have their joints converging to points near the arch, and are all therefore cut to different forms, the arch is called a *camber arch*. It will be seen that in a straight arch of this kind no two bricks are alike on the same side of the key, but those on the opposite sides correspond with each other, pair by pair. The ordinary way to describe this arch is to lay out the width of the opening, draw the soffit line with a *camber slip* (a piece of board one half inch thick and as long as the opening, and triangular in shape, having a rise of one eighth inch to the foot toward the centre of the opening), bisect the perpendicular line with *C* as centre and *C B* as radius. This is the point to which the lines are drawn to get the proper skew back. It is then necessary to measure the bricks to see how they will work. If two and one half inches, set of one and one fourth inches on each side of the centre line *A*, and draw lines to the point *C*, as shown; this will give the shape of the moulds, of which there ought to be three, made of stiff cardboard, and about eighteen inches in length. If the arch is to be one foot in depth, and in proportion if more or less, then mark them all about three inches from the narrow end. Fix one of these upon the centre line as shown at *A*, so the line above mentioned shall be exactly at the soffit line of the arch, and then trace the other two alternately toward the skew back, keeping each line on the moulds to the soffit line each time. The bevels must be taken for each course, and marked on the mould ready for working. One bevel will answer for soffit, cross joint, and top of each course, if it is reversed for the two last named (see Fig. 8); but sometimes it would be best to leave the tops and cut them when setting the arch, for very often mistakes are made in taking the length of the courses with the templet. Be sure and have the cross joints in this arch level and the courses uniform. Plain as this arch appears to be, it is however difficult to execute properly in practice; the full size of the arch should be drawn first, and the moulds taken as described, of course allowance being made for the joint when the cardboard is being cut for the mould.

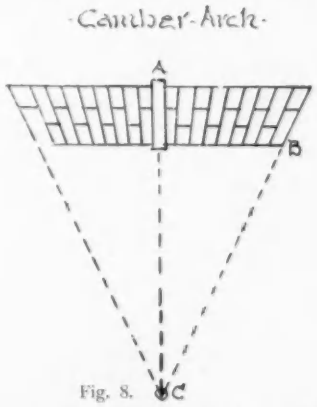


Fig. 8.

ARCHIE.

(*To be continued.*)

THE MANUFACTURER.

TIDINGS OF SPRING. — THE NEW ENGLAND MARKET.

AT this early day it is rather unsatisfactory to attempt to predict the building movement of the next season, especially in view of the unsettled condition of financial and business affairs. All that can be done is to state the conditions as they exist to-day in Boston and throughout New England, and to tell of the outlook as it now appears.

Brick building in Boston last year was unusually light up to the first of September, when a revival took place, which brought the total number of permits for new brick buildings to three hundred and ninety against three hundred and seventy-one the year before. This gain over the preceding year has been continued into 1895, and the permits granted up to middle of this month numbered forty-two, compared with thirty-four during the corresponding period of 1894, showing an increase of nearly twenty-five per cent, and this in spite of the unusually severe weather during the last three weeks.

There are reasons for believing that this increased activity will continue. It is generally conceded that the building of brick structures, stores, warehouses, and apartment houses has not been as large in comparison with the demand as has that of frame dwellings in the outlying wards and the suburban cities and towns. Frame apartment houses over three stories in height, now forbidden, will be allowed if certain amendments now before the Legislature, and likely to pass, are enacted. The increasing value of land in such districts as Roxbury and Dorchester, and in the centres of such places as Somerville, Cambridge, and many of the other cities of New England, make the erection of brick tenements and apartment houses more and more profitable and economical in the long run.

Another factor that is leading builders to use brick instead of wood is the nearer approach of the cost of the one to the other, the difference being narrowed constantly and, especially on high-priced land, making brick the cheapest material, considering what is obtained in the end.

The law which requires the fireproofing of the lower story and basement of a dwelling or tenement house, when the first story is used for other than domestic purposes, is very likely to be repealed. In fact it is almost sure to be, the insurance companies as well as the city and the builders being united in this movement. This will mean much to the brick makers, for the present law has put a stop to the building of houses with stores in them except on the highest priced land. It is believed that this change in the law will lead to a renewal of activity in the South End, and also the remodelling of many dwellings into stores on such streets as Columbus Avenue and Tremont Street, where the conditions would not warrant fireproofing as noted, but offer inducements to improvement without it. Even in the case of old buildings which are not entirely torn down this will lead to an increased demand for front brick, for in nearly every case a new front, more or less elaborate, is constructed when the alterations are made.

Another matter before the Legislature that will interest the terra-cotta manufacturers is a proposed amendment doing away with the masonry arches between the iron or steel beams in the construction of floors in first-class or fireproof buildings. This amendment would allow the substitution of wooden floors protected by fireproofing, such as metal lathing and plaster on the under side of the lower floor.

A number of large buildings in which brick will be used for the walls are in process of erection, or will soon be started in Boston. The most conspicuous and the largest is the new Tremont Building, to make way for which the old Tremont House is being torn down. It will have the eight upper stories built of light-colored face brick, and will cover a lot of nearly twenty-five thousand square feet. Winslow & Wetherell are the architects, and Norcross Brothers the contractors.

The Devonshire Building, of which Woodbury & Leighton are the builders, is another large office structure which calls for front brick. It will be on Washington, State, and Devonshire Streets, and the foundations are now going in.

Two large apartment hotels of brick are to be erected on Commonwealth Avenue. E. B. Horn is to build one, six stories in height, a short distance west of Massachusetts Avenve. Henry S. Mackay, of Mackay & Dunham, the architects, will build the other, between Hereford Street and Massachusetts Avenue. It will be ninety feet front and six stories high.

A new eight-story building is to go up on the corner of Tremont and Winter Streets, and another on the corner of Court Street and Cornhill. Both have been planned by Winslow & Wetherell, and brick and terra-cotta will be the principal materials used.

Even one not particularly interested in building must have noticed the great increase in the use of face brick and terra-cotta of late years in this vicinity. The State Street Exchange and the Ames building are almost the only conspicuous instances of the use of other material in an important mercantile structure recently erected, and both of these were erected before adoption of the steel frame principle of construction.

In the rebuilding following the disastrous fire of Thanksgiving day, 1889, brick was used in place of the stone that had melted before the flames. The new Farlow Building, a fireproof structure, which is going up on Lincoln Street, in place of the brownstone building destroyed in 1893, is to be built of brick. On the other side of Lincoln Street, on the corner of Essex Street, the Fred. Ames estate will build three five-story red brick buildings, aggregating over twenty thousand square feet in ground area.

A conspicuous illustration of modern construction, and a comparison with former methods showing the increased use of brick and terra-cotta, may be seen by any one who stands in Post-Office Square and looks first at the life-insurance buildings between Congress and Pearl Streets and then at the new Worthington Building on the corner of State and Congress Streets. The former are good examples of the employment of the heavy stone construction once so popular, and the latter of the newer school which employs the steel frame and the brick walls.

The beauties which lie in brick and terra-cotta skilfully handled are strikingly brought out in the new Castle Square Theatre, whose white walls and truly noble arch are a standing lesson in the artistic use of these materials, as well as objects of admiration to all who see them. Another building that has done much to show the possibilities of effective architectural work in brick is the Youth's Companion Building on Columbus Avenue, by many considered altogether the most satisfactory mercantile structure in Boston.

It is certain that not only has the use of clay products greatly increased the last few years, but that the demand for their employment in the best class of mercantile buildings is widening every day.

Considerable building of fine private dwellings on Bay State Road and other streets in the new Back Bay has been planned for this spring. The Roxbury "burned district" will also probably be rebuilt soon, and this time of brick. Driver & Dwight, architects, have plans for a large six-story apartment house in Dorchester, and W. A. & J. H. McGinty, for a large parochial school in the same district, both of which will be built this spring.

A demand has been made for a number of new schoolhouses for the city of Boston. Among those sure to be erected is a large one to be built on Myrtle Street.

Several large brick buildings will be erected by Ginn & Co. on First Street, Cambridge, to accommodate their publishing business. Another big brick building in the University city will be the new Middlesex registry of deeds, which will be begun some time this season.

The architects of this structure, Wait & Cutter, will also build an addition to the Lowell Court House.

Several new brick churches have been planned for suburban towns, among them a Methodist Temple for Cambridge, by Blackall & Newton, but this may not be begun this season.

In Lynn considerable new construction in the way of brick factories and mercantile buildings will take place, and several blocks are planned for Brockton.

Reports from Maine indicate a lively business there, and from all parts of New England come reports of a demand for new brick buildings, following reviving trade and industrial enterprise. It is impossible now to say that this promise of renewed activity will be fulfilled, but the outlook is generally regarded as hopeful.

MR. F. N. CARTER, Central Pressed Brick Co., Cleveland, has perfected a kiln which he claims is a great success in operation. He states that it is an entirely new departure from any kiln on the market, being built on the principle of a circular shaped continuous tunnel, so divided that the brick are subjected to a graduated heat from the green state to the maximum heat, and then gradually cooled to handling temperature. The manner of operation in this kiln is briefly as follows: the kiln itself is horizontal, the point of the greatest heat being midway in the circumference at equal distance from the two ends, wherein the circle of the whole is broken to admit of the entrance and extraction of the brick. The method of handling the bricks is as follows: they are laid in tiers of eight on specially constructed cars which traverse an iron track running through the entire kiln, and emerging at the same point, practically, as entering, after traversing the entire distance of the kiln. These cars are moved automatically in such a manner as to gradually approach the point of greatest heat, and after, to become gradually cool by passing from it to that of less temperature by the same onward movement of the car. Mr. Carter claims that the proper length of transit of this car to produce a properly burned brick need not to be over four days from the entrance of the green brick to exit of one perfectly burned. It should be understood that the principle of this kiln is continuous. One car follows another regularly, and as fast as may be; the speed being properly regulated to subject each car the required length of time to the burning process. The patentee claims that by his method of burning each brick may be made to assume the exact color of each and every other brick of the same composition; that the firing will be identical in degree of heat, and may be so regulated that absolute uniformity in burning can be guaranteed.

THE SOMERSET & JOHNSONBURG MFG. CO., are at present adding two new kilns to their works at Somerset, Mass. These have the capacity of twenty-two thousand each, and are built on the principle of the circular down-draft kilns.

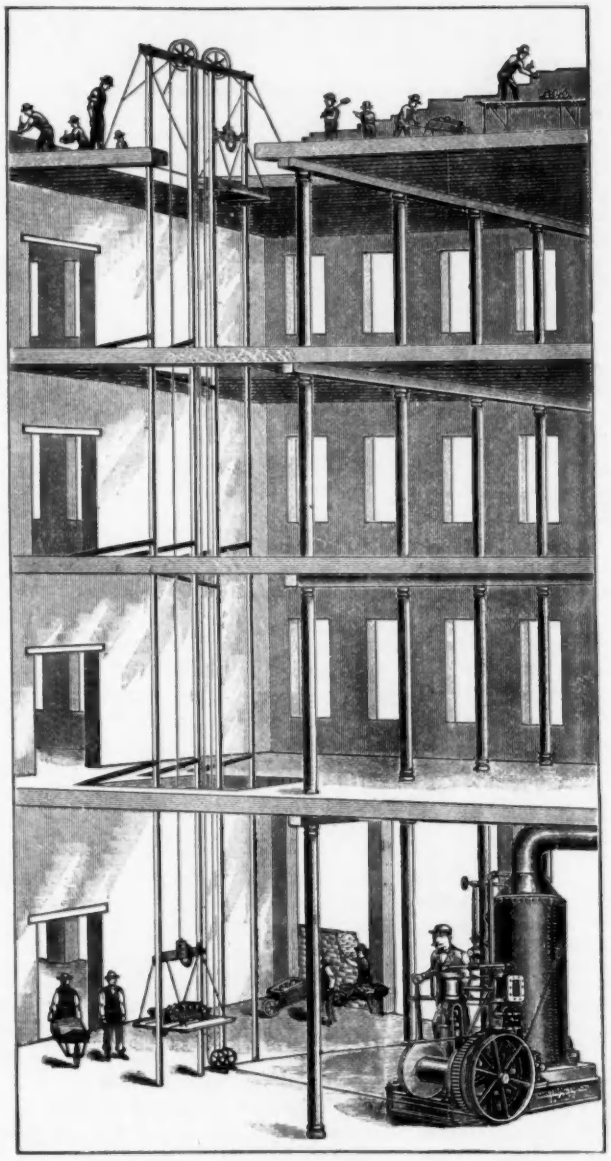
THE TIFFANY PRESSED BRICK CO., Chicago, have secured the contract for the enamelled brick to be used in the new City Hall at Jacksonville, Fla. It is probable that the entire lot will be white enamel.

THE EMPIRE FIRE-PROOFING CO., Pittsburg, are getting out material for the Moody Building at Buffalo. Messrs. Beebe & Son, architects.

THE INDUSTRIAL PRESS BRICK CO., 46 South Street, New York, are making some alterations and extensions at their plant.

THE PEERLESS BRICK CO., Philadelphia, are about to increase the capacity of their yard.

THE WINKLE TERRA-COTTA CO., of St. Louis, are building an extension to their works.



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